SURGERY

VOL. 2 NOVEMBER, 1937 NO. 5

Original Communications

Symposium on Peptic Ulcer

THE PHYSIOLOGY OF PEPTIC ULCER

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THE rapid strides that have marked surgical progress during the past few decades have been due in the main to the continuous endeavor to correlate experimental physiologic alterations with aberrant clinical manifestations and to the more recently acquired clinical attitude of developing a therapeutic attack through a thorough comprehension of the disordered physiology. Rationale, i.e., the logical basis of a procedure, is the essence of present-day surgical therapy. Thus, the importance of physiology becomes obvious because a rational therapeusis can be developed only through a complete understanding and correlation of the fundamental physiologic principles and their derangement in disease.

The subject of peptic ulceration is indeed an excellent example of this form of progress and the important significance of a comprehension of the underlying physiologic alterations. Any attempt to discuss intelligently this paramount condition without an exposition of the physiologic mechanisms involved in its development would be nugatory.

The voluminous clinical, statistical, and experimental investigations that are perennially contributed on this subject attest to its bewildering pathogenesis. Because of the prominence of the local ulcerative lesion and the specialized interests of the various workers, most studies have been unwittingly focused on the ulceration per se, and, instead of clarifying the problem, they have merely added to the existing maze of confusion. Whereas this has given rise to multifarious hypotheses and to diversity of opinion which clearly reveal the perplexing problems of its causation and make it safe to assume that no one factor can be held

Received for publication, September 23, 1937.

responsible for ulcers in general, nevertheless certain factors have emerged as playing important rôles in the etiology and pathogenesis of the disease. It is our purpose here to analyze and discuss, from the physiologic standpoint, these factors whose importance in the development and maintenance of peptic ulceration have been indicated through experimental and clinical investigations. These factors may be classified under the following captions: (1) constitutional, (2) chemical, (3) tissue susceptibility, (4) mechanical or traumatic, and (5) infection.

The Constitutional Factor.—The importance and existence of an inherent factor predisposing to the development of ulcer in certain individuals can no longer be denied, but it is extremely difficult to define or state exactly what constitutes this factor. Whereas it has been possible to investigate certain phases of this problem in the experimental laboratory, most of the evidence has come from clinical observations and investigations. Among the first to direct attention to this innate characteristic were Draper and others.[1] Their studies revealed that the ulcer-bearing patient has certain characteristic anthropometric relations as well as certain psychologic factors which are measurable components of the "ulcer constitution." Stenbuck[2] made similar observations and expressed the belief that these individuals have characteristic facies, which are usually thin and drawn with high malar prominences, are poorly nourished and energetic in demeanor, and present an anxious expression. Hurst[3] believes that the essential predisposing factor in the production of duodenal ulcer is the presence in an individual of hypersthenic gastric diathesis, which manifests itself in hypertonus and hyperchlorhydria. He is of the opinion that its occurrence in several members of a family suggests its probable hereditary character. This familial tendency has also been stressed by Huddy[4] and McVicar[5] as well as by others. The recent studies of Meyer and others[6] are of interest in this regard. An analysis of the gastric secretion in a large group of healthy members of "ulcer families" revealed an abnormal response to the Ewald meal and a high acidity of the resting stomach. They interpreted the results obtained as an "expression of an abnormal gastric mechanism, so far unknown, which may produce both abnormal secretion and ulcer." Wilkie[7] states "there is a type of individual peculiarly prone to ulcer and that heredity plays a part."

Other investigators have attempted to define this ingrained characteristic in a more specific manner. With a capillary microscope Müller and Heimberger[8] examined fresh specimens immediately following partial gastrectomy and found spasm and atony of the arterioles, capillaries, and venules of the gastric mucous membrane. They refer to this as a "vasoneurotic diathesis" which they believe is a congenital or acquired "disharmony" in the structure and function of these small blood vessels. Many observers have stressed some derangement of the nervous system as the most significant single factor in the causation of

peptic ulceration. Supposedly there exists a "disharmony" between the vagi and their anatagonists, the sympathetics, which leads to disturbances in secretory and motor functions. The constant, irritating nervous stimuli eventually lead to localized spasmophilia of the duodenal or gastric musculature, which in turn effects areas of mucosal or submucosal ischemia. The final erosion of the mucosa is due to the consequent diminished resistance in these localized areas, and the prolongation of this nervous irritability with the resulting hyperacidity accounts for the production of chronicity. According to this hypothesis all ulcers fall into two classes; viz., vagotonic with abnormally increased vagus tone or sympathicotonic with abnormally increased sympathetic tone. Experimental investigations along this line have followed three methods of approach: (1) severance[9-12] or stimulation[11, 13, 14] of the vagi; (2) irritation or extirpation of the sympathetics and celiac plexus[15-19]; and (3) irritation or stimulation of the central nervous system.[20, 22, 31] Physiologists are now agreed there are at least three phases in normal stimulation of gastric secretion. The initial or cephalic phase is dependent upon psychic stimuli mediated by the vagi. Some observers[23-26] have suggested that hyperactivity of the vagi may produce an increase in the rate of secretion of the gastric acids which in turn is conducive to ulceration. In a recent publication Ferguson[27] reviewed this phase of the subject and concluded that; whereas, vagotomy is more likely to produce hemorrhagic lesions and acute erosions than true chronic ulcers, splanchnicotomy and adrenalectomy are probably even more effective in producing such lesions. The results obtained in his own experiments on the effects of vagotomy on gastric functions of monkeys demonstrate that the "gastric and intestinal phases of acid and chloride secretion are well able to continue in spite of the operative severance of the vagus nerves." Crile[28-30] has been one of the leading advocates of sympathico-adrenal hyperirritability in ulcer development. Experimental investigations on this relationship have met with varying degrees of success.[31-35] Wolff and Thomas[36] studied a group of patients with gastric neuroses and ulcer and found evidence of autonomic imbalance. These authors believe that irritative impulses, either central or peripheral, may be conveyed by means of the vagus nerve and sometimes, although rarely, by the thoracolumbar branches through the gastric and duodenal systems. As a result of his observations on the simultaneous occurrence of cerebral lesions and peptic ulcer, Cushing[37] has suggested that irritative disturbances in the vagal centers of the brain stem, resulting from worry, anxiety, and heavy responsibility, may produce chronic hyperacidity, often effecting ulceration. Stimulated by these clinical observations numerous investigators have attempted to adduce evidence indicating a causal relationship between intracranial involvement (hypothalmus,[38-42] hypophysis,[43] cerebral cortex[44]) and certain gastrointestinal disturbances. It is very difficult to draw positive conclusions from the results of these investigations, but

in general they seem to assign a definite significance to neural derangements in the genesis of ulcer. The importance of psychic trauma in the development of peptic ulcer has been emphasized by Rivers.[45] Among 200 specialists in medicine, he[45] found an almost 20 per cent incidence of peptic ulcer and an additional 20 per cent who admitted taking alkalies at intervals. He stated that these findings are of more significance in comparing the results in a similar study among 200 negroes, in none of whom ulcer was encountered. Steigmann,[46] however, stresses the psychogenic factor even in the negro, because he found a 12.7 per cent ulcer incidence, and states that these northern negroes are vastly different from the indifferent types of Texas negroes. He is of the opinion that "environmentally conditioned psychic factors play an equally important rôle in the genesis of peptic ulcer in white and negro patients." Robinson[47] believes that emotional conflicts in an individual with ulcer diathesis are alone essential for the production of chronic gastroduodenal ulcer. He[48] advances the view that "these individuals with their fears and anxieties develop an imbalance of the vegetative nervous system." On the assumption that the "anxiety complex" may cause ulcer by producing a condition of sustained gastric hypersecretion and hypermotility, Orndorff, Bergh, and Ivy[49] studied this factor experimentally by inducing this state pharmacologically. Although acute lesions were common, no chronic ulcers developed.

CHEMICAL FACTORS

A disturbance in the chemical and physiological relationship of the acid gastric juices on one side and the alkaline duodenal secretions on the other in the development and maintenance of peptic ulceration has long been suspected. Whereas the accumulated clinical and experimental evidences have established its indubitable significance, nevertheless its exact nature is still imperfectly understood. The strictly limited localization of the occurrence of ulcer with striking uniformity in only those areas which are habitually bathed in acid chyme and in other parts of the intestinal tract only under exceptional circumstances which permit exposure to the gastric secretion has indicated the culpability of the acid gastric juice. Investigators throughout the world have been stimulated to produce experimental evidence to substantiate the possibility of an insufficient neutralization; i.e., some abnormal inability of the alkaline duodenal juices to neutralize the normal or probably hyperacid gastric secretion or to demonstrate some factor which might be totally absent, abnormally increased, or unusually diminished. It will, of course, be impossible to attempt here a detailed review of the enormous clinical and experimental data that has accumulated in support of this factor. It will be necessary to confine this discussion to a brief outline of the more pertinent clinical and experimental facts.

Considerable importance has been attached to the frequent occurrence of hyperacidity in patients with peptic ulcer. Studies of large groups of gastroduodenal ulcer cases have demonstrated that there occurs a normal acidity in approximately one-third of the cases and a hyperacidity in almost one-half.[50-55] Although it is generally believed that there is no diagnostic acidity curve in gastric ulcer, hyperchlorhydria with hypersecretion is thought by many to be almost pathognomonic of active duodenal ulcer.[56-59] The interesting studies on the interdigestive phase of gastric secretion are particularly enlightening in this respect. During such fasting periods the acid gastric juice, undiluted and unneutralized, may be especially harmful to the mucosa. Obviously, the gastric secretory activity during sleep at night should be the most significant because this is the longest fasting period. Such investigations clearly reveal that normal subjects have a characteristic nocturnal secretory rest in contradistinction to ulcer patients whose gastric secretion is unusually active and contains uniformly high acid values.[60-63] The effect of experimentally produced hyperacidity by the feeding of dilute hydrochloric and other acids has been studied by many investigators.[10, 64-72] Whereas such an artificial hyperacidity may produce lesions ranging from simple erosions to actual ulceration, the conclusions reached by most of these observers was that it is of no significance except in considerably higher percentages than that found in the human stomach even in the presence of ulcer.

Because of its stimulating effect on gastric glands,[73-75] histamine has been extensively employed in studies of ulcers experimentally produced in various animals, such as the rat,[76-79] the cat,[80, 81] the rabbit,[82] and the dog.[72, 82, 83] The results obtained by most of these observers indicate that histamine by its stimulative action on gastric juice is capable of producing changes in the mucosa varying from simple erosion to acute and chronic ulcers. In an attempt to evaluate the significance of increased gastric acidity obtained by feeding hydrochloric acid and by stimulation with histamine, Ochsner, Gage, and Hosoi[83] found that erosions or ulcers developed in 27 per cent of the animals studied.

Relatively recently it has been adequately demonstrated that by the oral administration of cinchophen, it is possible in the dog to produce ulcers consistently, having all the characteristics of those observed in man.[84-88] The importance of the acidity factor in the development of such ulcers has been clearly demonstrated by Stalker, Bollman, and Mann.[86-88] In an interesting group of rigidly controlled experiments they showed that the presence of free hydrochloric acid was essential for the development of peptic ulcers produced by cinchophen.

In order to study the influence of gastric acidity better, numerous experiments have been devised to evaluate the significance of the counteracting neutralizing effects of the alkaline duodenal secretions. The

diversified and numerous procedures devised for this method of approach practically all have a similar underlying principle and their purpose in the majority of instances has been to determine the relative protective values of the alkaline juices alone and in combination with each other.

Bickel[89] was one of the earliest to recognize the importance of the alkaline duodenal secretions in preventing the formation of ulcer. In 1909 he performed duodenectomy in two dogs after closure of the pylorus, reestablished continuity of the gastrointestinal tract by gastroenterostomy, and sutured the bile and pancreatic ducts to the skin of the abdomen. One month later one dog died of perforation with resulting peritonitis of one of several jejunal ulcers just distal to the stoma. Five years later Langenskïold[67] devised an experimental operation on the dog which eventually led to the more consistent ulcer-producing procedure of Mann and Williamson.[90] After severing the duodenum just proximal to the opening of the bile duct and closing the distal end, he severed the jejunum several centimeters distal to the duodenum and anastomosed the distal end to the proximal end of the duodenum and joined the proximal end of the jejunum to a loop of jejunum further caudad. Thus bile and pancreatic juices were shunted to the lower part of the small intestine. The animal was sacrificed a month later, and an ulcer was found in the short segment of the duodenum between the stomach and the jejunum. In 1923 Mann and Williamson[90] slightly modified Langenskïold's operation by severing the duodenum at the pylorus and at its junction with the jejunum, closing its oral end, and anastomosing its distal end to the terminal portion of the ileum, and then anastomosing the proximal end of the jejunum to the pylorus. This "surgical duodenal drainage" procedure shunted the entire alkaline duodenal secretions away from the jejunum and into the lower ileum and resulted in the consistent development of typical chronic ulcers in the jejunum just distal to the gastrojejunal stoma. These results have been corroborated by many other investigators.[91-94] It has been irrefutably established that deviation of all the alkaline duodenal juices will inevitably result in the formation of such ulcers.

These procedures effect a persistent state of high gastric acidity, which might account for the production of ulcer. Because Boldyreff[95] maintained that the acidity of the gastric juice is regulated by the regurgitation of the duodenal alkali into the stomach, experiments have been devised to determine whether or not a reflux of the entire duodenal contents into the stomach prevents or heals ulcers. Chlumsky,[96] Schmilinsky,[97] and Keppich[98] obtained no ulcer after these experiments; on the other hand, McCann[99] obtained jejunal ulcers in 80 per cent of twenty-six dogs. Graves[100] slightly modified the McCann procedure so that instead of deviating duodenal secretions into the fundus of the stomach it was deviated into the prepyloric region, and he obtained no ulcers in his group of experiments. Weiss, Graves, and Gurriaran[101]

confirmed these findings. These experiments emphasize the importance of gastric acidity in the genesis of ulcer, especially in the absence of the neutralizing effect of the alkaline duodenal secretions.

Because of the obvious protective value of the alkaline duodenal juices in preventing the formation of ulcer, numerous experiments have been performed to determine which of these secretions, if any, that is, the succus entericus, the pancreatic, or the biliary juices, plays the feature rôle. Although these procedures are diversified in nature, the underlying principle of excluding one or more of these juices either separately or in combination has been the same. The effect of the combined deviation of bile and pancreatic juices, thus permitting the protective influence of the succus entericus to remain, has been studied with varying and contradictory results.[90, 102-104] By eliminating only the duodenal secretion and thus permitting the bile and pancreatic juices to remain, the protective influence of the succus entericus has been indirectly determined.[90, 93, 105, 106] Graves[100] performed duodenectomy in three stages and came to the conclusion reached by most of the other observers that in the experimental animal the duodenum is apparently not essential to life and its secretion alone is not altogether sufficient protection against the formation of ulcer. On the other hand, Mann and Bollmann and their coworkers,[68, 107, 108] as a result of their investigations, contend that the duodenal mucosa and secretions are the most important in preventing ulcer formation.

The protective influence of pancreatic juice has been determined indirectly by its elimination either by total pancreatectomy, by ligation, by transplantation of the pancreatic duct, or by the production of a fistula in the pancreatic duct.[100, 103, 109-116] The results obtained by most of these observers indicate that pancreatic juice does not have an important protective influence in the production of ulcer. In contrast to this, however, Elman and Hartmann,[117] Matthews and Dragstedt,[118] and Hoerner[119, 120] found evidence that pancreatic juice has a definitely protective influence against ulcer formation. Hoerner[121-123] further emphasized the importance of the acid neutralizing effect of the pancreatic secretion by demonstrating its quantitative buffering capacity and the effect of its exclusion on the pH of the gastric duodenal and jejunal contents.

The influence and the effect of the biliary secretions have been studied by methods similar to those used in the study of the pancreatic secretions. Kapsinow[124] deviated bile in dogs to the pelvis of the kidney and obtained a relatively high incidence of ulcer formation. Others[93, 100, 103, 116, 125, 126] deviated the bile into the lower portion of the ileum and obtained ulcers in a relatively high incidence of the animals. Rous and McMaster[127] studied the effect of the exclusion of bile by a special sterile fistula method and noted no ulcer formation. On the

other hand, Berg, Johnson, and Jobling,[114, 128] using a similar method, obtained ulcers in a relatively high incidence. Blanck[129] not only showed that such complete external drainage of bile resulted in ulcer formation, but also that the incorporation of fresh bile in the feedings of these dogs could prevent the development of these ulcers. However, Mann and Bollmann[68, 107] minimize the protective influence of bile. Working in their laboratory, McRoberts[130] attempted to support their contention by demonstrating that the pH of the duodenal contents is not significantly altered following the loss of bile. Ochsner, Gage, and Hosoi[83] have rather convincingly demonstrated the protective influence of bile. After performing a gastric pouch of the Heidenhain type from the greater curvature and of the Pavlov type from the lesser curvature, they[83] anastomosed the proximal portion of the jejunum to the pouch. Ulcers occurred in 100 per cent of the animals in which the former procedure was done and in 71 per cent in which the latter procedure was done, or an average of 85 per cent. In another series in which the procedure was similar to the foregoing, but with the addition of anastomosis of the fundus of the gallbladder to the pouch, the incidence of ulcer was reduced from 100 to 28 per cent in the Heidenhain pouch dogs and from 71 to 50 per cent of the animals with a Pavlov pouch, or from an average of 85 per cent in the first series in which there was no bile present to 39 per cent in the latter group in which bile was present.

Because of the difficulties in drawing conclusions from the confusing and contradictory experimental results obtained by different observers in attempting to evaluate the relative protective influence of each of the alkaline duodenal juices, I[131] performed a series of rigidly controlled experiments. A total of sixty dogs was used and divided into four groups. In the first group the pylorus was severed and the gastric and duodenal ends were closed. Continuity was reestablished by anterior gastrojejuunostomy. In the remaining three groups a similar procedure was performed, but with the addition of ligation and division of the accessory pancreatic duct and transplantation of the main pancreatic duct into the terminal portion of the ileum in Group II, the transplantation of the common bile duct into the terminal portion of the ileum in Group III, and the transplantation of both the bile and pancreatic ducts into the terminal portion of the ileum in Group IV. In this way all of the animals were subjected to the same extrinsic factors except one, the deviation of pancreatic juice in the second group, the deviation of bile in the third, and the deviation of both bile and pancreatic juice in the last group. In the first group in which none of the alkaline duodenal juices were deviated, 50 per cent of the animals developed ulcer; in the second group in which pancreatic secretion was deviated, 70 per cent of the animals developed ulcer; in the third group in which bile was deviated, 90 per cent of the animals developed ulcer, and in the fourth

group in which both pancreatic juice and bile were deviated, all of the animals developed ulcer. Based upon these experimental results, bile seems to have the most significant and effective influence in preventing the formation of jejunal ulcer. Of the duodenal secretions, the succus entericus apparently is the least important, and the pancreatic juice seems to be midway between the two in this respect.

Another link in the chain of evidence against the etiologic significance of acid peptic activity of the gastric secretion is the consistent relationship of peptic ulceration and acquired and congenital heterotopia. Meckel[132] first described the diverticulum which bears his name in 1815, and now the clinical picture of ulceration and perforation resulting from the adjacent dystopic gastric mucosa producing its acid peptic secretion present in Meckel's diverticulum is definitely established.[133-136] Mondor and Lamy[137] recently reported nearly 100 cases of ulcers of Meckel's diverticulum. Artificially produced Meckel's diverticula in the experiperimental animal have also resulted in a high incidence of peptic ulcer.[118, 138-140]

Numerous observers have noted that condiments, alcohol, and tobacco are aggravating to patients with peptic ulcer.[141-144] The deleterious influence of these substances is probably twofold; viz., the direct irritative effect on the gastric and duodenal mucosa resulting in gastritis and duodenitis, and the indirect effect on gastric secretion resulting in hyperacidity. Alcohol is such a powerful stimulant of gastric secretion that it is frequently used as a test meal.[145, 146] That tobacco smoking produces hyperacidity and is, therefore, detrimental to ulcer patients has been demonstrated by many investigators.[147-150]

From the foregoing brief review of the clinical and experimental investigations, it can readily be observed that the acidity factor plays an important rôle in the genesis of peptic ulceration. It can no longer be doubted that pure, undiluted gastric juice can produce ulcer. Obviously, many of the experimental states resulting in ulcer by the establishment of unphysiologic conditions do not exist in the human being. However, they demonstrate convincingly the significance of acid peptic secretions. Whether in the human this acidity factor becomes relatively more important because of faulty or improper neutralization or because of overactivity due to some stimulative effect cannot be definitely stated, but its real significance can no longer be denied.

Tissue Susceptibility.—The significance of tissue susceptibility as a predisposing factor in the genesis of ulcer has resulted from experimental and clinical investigations which reveal that certain portions of the gastrointestinal tract, namely, the lesser curvature of the stomach (magenstrasse), the duodenal cap, the jejunum, and other portions of the intestinal tract subjected to acid gastric secretions, seem to have an inherent vulnerability to peptic ulceration. Obviously, this factor

is closely related to the acidity factor, because ulceration rarely occurs in these areas unless they come in contact with acid gastric chyme. However, their strictly limited localization with striking uniformity cannot be solely explained by the acid peptic activity of the gastric secretion. The bulk of evidence indicates that they possess an intrinsic quality of susceptibility; or to state it differently, there would appear to be an inherent lack of the ability to resist the digestive eroding effect of the acid gastric juice.

It has long been known that gastric ulcers frequently occur along the lesser curvature and that ulcers rarely develop along the greater curvature in spite of the fact that the greatest acid secreting area in the stomach lies in the fundus. Morton[151] observed that after "surgical duodenal drainage" ulcers along the greater curvature healed; whereas, those on the lesser curvature became chronic. Gage, Ochsner, and Hosoi[152] have very convincingly demonstrated this greater sensitivity of the mucosa along the lesser curvature to peptic ulceration. In one group of experiments the greater and lesser curvatures of the stomach were respectively extirpated. Whereas the incidence of ulceration was 63.8 per cent in those cases in which the lesser curvature remained after extirpation of the greater curvature, no ulcers developed in the group in which the greater curvature remained after removal of the lesser curvature. These experiments more clearly demonstrated the importance of tissue susceptibility when it is recalled that ulceration occurred in a relatively high incidence in that group of experiments in which the acid-bearing area of the stomach was removed, that is, the greater curvature. That a definite gradient in susceptibility to ulcer occurs with the aboral distance from the pylorus has been shown by many investigators. McCann[99] and Ivy and Fauley[153] so modified the Mann-Williamson procedure that a small segment of duodenum remained interposed between the stomach and jejunum, and they observed that in these animals the ulcers always formed in the jejunum, indicating that it was more susceptible to injury than is the duodenum. Mann and Bollmann,[68] Harper,[140] Matthews and Dragstedt,[118, 154] and McMaster[155] have definitely corroborated the fact that there is a commensurable susceptibility of the intestinal tract to acid gastric peptic activity as the distance from the pylorus is aborally increased. Matthes[156] long ago showed that hydrochloric acid would more easily injure the ileum than the jejunum and the duodenum. The frequent occurrence of ulceration in the intestinal mucosa immediately adjacent to existing gastric mucosa in a Meckel's diverticulum further supports this premise.[135, 136] This condition has been experimentally duplicated by making small Pavlov pouches of gastric wall which were transplanted into the ileum with the resultant development of ulcers.[118, 154] Gage, Ochsner, and Hosoi[152] also noticed similar ulceration when the jejunum received this acid gastric juice. This is further supported by the clinical observations of the de-

velopment of jejunal ulcers following gastrojejunostomy. Although the recorded incidence of jejunal ulceration following gastrojejunostomy in human beings reveals a marked variance of from 1 to 2 per cent to as high as 52 per cent,[157-168] it occurs with sufficient frequency to bear a real significance.[169] As a result of his own statistical survey which reveals that of thirty-one gastroenterostomies performed for benign lesions, 48.3 per cent developed jejunal ulcers, and a study of the literature, Newburger[170] emphatically condemns the procedure in the treatment of gastroduodenal ulcer. The increased susceptibility of the jejunal mucosa to ulceration has been further confirmed by other experiments performed in the Tulane Surgical Laboratory. In a series of twenty dogs in which pyloric occlusion and gastrojejunostomy were performed, jejunal ulcers developed in 50 per cent.[171] This is admittedly a high incidence, but why should ulcers develop at all after this procedure? The gastrointestinal physiology does not seem to be altered to such a commensurable degree; there is no deviation of alkaline juices; and the gastrointestinal acidity should not be increased. It would appear that the best possible explanation is that the jejunal mucosa is functionally unable to receive acid gastric chyme, and this factor is relatively more pronounced after this procedure as the pyloric occlusion does not permit a regurgitation of the alkaline duodenal juices into the stomach to help neutralize the gastric acidity.

Mechanical or Traumatic Factor.—Aschoff[172] was one of the first to stress the importance of the mechanical factor. His conception was based upon a comprehension of the function of the so-called "magenstrasse" or gastric pathway, which is formed by the characteristic arrangement of the folds of the gastric mucosa along the lesser curvature and is assumedly the route by which gastric chyme is propelled from the pylorus into the duodenum. Mann[173] contends that there are two important factors in the causation and prevention of healing of ulcers produced by their "surgical duodenal procedure"; namely, a chemical and a mechanical factor. He emphasizes the fact that an ulcer develops at the site where the mucosa is subjected to the greatest force of impingement of the gastric chyme as it is propulsed from the stomach in a nozzle-like manner. To emphasize this propulsive action further Mann[173] performed the "surgical duodenal drainage" operation and then produced a typical hourglass stomach in the prepyloric region so that the stomach was divided into pouches, communicating at the lesser curvature through a small opening. In this manner the propulsive power of the stomach was considerably lessened, and these animals were remarkably resistant to the development of ulcer. McCann[174] further stressed the importance of this mechanical factor by the demonstration in one ulcer specimen of fifty or more hairs of the dog embedded in the sloping wall of the distal half of an ulcer. He surmised that the gastric chyme was thrown against this segment with sufficient force to embed the hairs

in the wall of the ulcer. The importance of the traumatic factor has been stressed by Baggio[175] in experiments in which the anterior wall of the stomach was folded so as to produce an obstruction. Lesions ranging from simple erosions to typical ulcers were observed, which he attributed to the traumatic action of the ingesta and the obstruction caused by the introflexion. Slocumb[176] established partial obstruction of the duodenum in dogs, which was followed by inflammatory changes and multiple ulcers. Whereas following excision of gastric mucosa chronic ulceration of the stomach could be produced experimentally by feeding rough, irritating food, none developed during administration of non-irritating foods.[177-179] There is also considerable clinical evidence to support the contention that prolonged trauma of the gastric mucosa incident to foreign bodies[180-183] and diaphragmatic hernia[184, 185] may produce chronic ulceration.

Another mechanical or traumatic factor is gastric retention as a result of interference with the proper emptying of the stomach and the normal regurgitation of the alkaline duodenal secretions. Whether this is functional in the sense of spasm of the pyloric sphincter,[186-188] or absence of normal relaxation, achalasia,[189-192] or actual mechanical obstruction resulting from cicatricial contraction or tumor formation, is of more academic interest than practical importance, because the resultant effect is the same. Interference with proper emptying of the stomach operates in a twofold manner; viz.: (1) gastric retention which augments and prolongs gastric motility and gastric acid secretion, (2) prevention of normal duodenal regurgitation which is the major factor in the neutralization of gastric acidity.

INFECTION

The contention that ulcer formation is the result of focal, toxic, embolic, or specific bacterial influences is supported by extensive clinical and experimental investigations. Boettcher,[193] in 1874, is credited usually with the first demonstration of bacteria in the marginal tissue of ulcer. Since then innumerable investigators have attempted to show a definite relationship between infection and the formation of ulcer.

The results of some studies in this respect have suggested the postulation of a specific infection.[194-200] Probably the most enthusiastic and intransigent advocates of this factor are Rosenow and his coworkers.[194, 196, 197, 201] As a result of their investigations these workers contend that there exists a specificity of certain organisms for a particular type of tissue which they term "elective localization." In the case of ulcer they have been able to isolate from septic foci, such as the teeth, the tonsils, and the sinuses of patients, certain strains of streptococci which in animal experimentation reproduced lesions similar to the type from which the patient suffered. On the other hand, other investigators[202-207] have shown the significance of nonspecific infections. Whether a focus of

infection, usually apparently innocuous, can under certain conditions act as a distributing center for organisms that have developed a localizing affinity for particular tissues at a distance and can there produce characteristic inflammatory lesions is still a disputable problem.

The frequency of the coexistence of peptic ulcer and intraabdominal foci of infection, such as chronic appendicitis and chronic cholecystitis, is believed by many to indicate a causal relationship.[45, 186, 191, 192, 208, 209] It is thought that such intraabdominal foci act as a trigger release for stimuli which disturb the balance of nervous control of the pylorus, producing either a pylorospasm or achalasia with consequent gastric retention and interference with normal duodenal regurgitation.

As a result of the great number of gastric resections in the German clinics, abundant and valuable material was furnished the pathologists in their microscopic study of gastric and duodenal ulcer. The results of their investigations suggest that ulcer formation depends upon a more or less acute inflammatory process of the mucosa with resulting damage of the proteolytic action of the gastric juice. They were able to demonstrate with striking uniformity a characteristic gastritis, duodenitis, and folliculitis.[210-215]

SUMMARY

A recapitulation of the voluminous clinical and experimental investigations merely reiterates the ineluctable fact that no single factor can be held responsible for peptic ulceration in general. Undoubtedly in some instances certain factors play the most conspicuous rôles. However, these studies clearly indicate that ulcer is the result of a tesselation of factors. A physiologic comprehension of their significance is established more readily by their analysis under the classification of: (1) constitutional, (2) chemical, (3) tissue susceptibility, (4) mechanical or traumatic, and (5) infection.

In a most perspicuous disquisition of this subject, Ochsner and his coworkers[216] have expounded a thoroughly rational understanding of the physiologic principles involved in the development and maintenance of peptic ulceration. This concept maintains that ulcer is established by the summation of two groups of factors: (1) the *predisposing,* which may be considered as uncontrollable in the sense that they are inherently present, and (2) the *precipitating,* which are controllable, i.e., can be modified.

The first group consists of two predisposing factors: (1) tissue susceptibility and (2) constitutional. By tissue susceptibility is meant an inherent vulnerability of certain portions of the gastrointestinal tract to the digestive eroding effect of the acid gastric juice. These areas comprise the lesser curvature of the stomach (magenstrasse), the duodenal cap, the jejunum, and other portions of the intestinal tract which

may be exposed to acid gastric chyme, such as Meckel's diverticulum containing gastric mucosa. This innate characteristic is present in all individuals. On the other hand, the constitutional factor exists only in those individuals who develop ulcer. Although it is extremely difficult to define or state exactly what constitutes this factor, its importance and existence can no longer be denied. That there is present in certain individuals an ingrained proneness or susceptibility to gastroduodenal ulceration has been repeatedly demonstrated.

Whereas both these predisposing factors may be present in an individual, peptic ulcer does not necessarily develop. However, ulceration does occur if to this predisposition group there is added the precipitating factors. This latter group of factors consists of (1) chemical, (2) mechanical or traumatic, and (3) infection. By the chemical factor is meant a disturbance in the normal physiologic relationship of the acid gastric juice on one side and the alkaline duodenal secretions on the other which is manifested by hyperacidity and hypersecretion. The importance and significance of this precipitating factor has been repeatedly demonstrated by clinical observations and experimental investigations. The frequent occurrence of hyperacidity in patients with ulcer and the strictly limited localization of the lesion with striking uniformity in only those areas which are habitually bathed in acid chyme and in other parts of the intestinal tract only under exceptional circumstances which permit exposure to the gastric secretion have established hyperacidity and hypersecretion as preeminent factors in the development of peptic ulcer. Whether in the ulcer patient this acidity factor becomes relatively more prominent because of faulty or improper neutralization or because of overacidity due to some stimulative effect cannot be definitely stated, but its real significance can no longer be denied.

The other precipitating factors are mechanical or traumatic and infection. By the former is meant the traumatic effect of rough foods, the concept of the "magenstrasse" as the gastric pathway, and gastric retention resulting from pylorospasm or achalasia, which is conducive to hypersecretion and hyperacidity and interferes with normal duodenal regurgitation. Infection may be operative directly by producing specific inflammtaory changes, or indirectly, when the focus is intraabdominal, by producing pylorospasm and consequent gastric retention.

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THE PATHOLOGY OF GASTRIC ULCER

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THE pathologist's interest in gastric ulcer centers about three problems: (a) the cause of the disease; (b) its morbid anatomy; and (c) the functional changes associated with the presence of ulcer and the complications which may arise from it. It is our present proposal to discuss these aspects of the problem as succinctly as may be possible.

The cause of chronic gastric ulceration still remains a mystery. It is true that in certain toxic or septic conditions such as uremia or burns, small superficial acute ulcers, and hemorrhagic erosions which may become ulcers (Fig. 1) develop, but these throw little light upon the real problem of the indolent chronic ulcer. These acute ulcers, which commence as small foci of necrosis, hemorrhage, or thrombosis in the mucosal vessels, with a surrounding inflammatory reaction, may develop into shallow erosions which may extend so as to involve the muscularis and even perforate, but as a general rule they are merely transitory and unimportant lesions which heal without serious involvement of the muscular coats which leave no scar behind. Except that they may be regarded as illustrative of the initial stages of gastric ulceration of any type these multiple mucosal lesions are of little interest for our main problem and we may leave them.

The problem with which we are really concerned is that of the single chronic ulcer. It is true that we occasionally see this ulcer in its acute phase and the picture thus presented (Fig. 2) is of value since it informs us upon a stage, which we can assume generally to be a short one, through which the lesion must pass before the chronic ulcer is evolved. This stage is, however, only rarely encountered in surgically removed material, and much that has been written upon acute ulcers, especially on the statistical side, is of little importance for our present purpose since the data have been gained from postmortem material in which the lesions often represent terminal complications in those dying of other forms of disease.

Returning to our main problem, it is clear that the chronic ulcer is dependent upon quite different factors from those which occasion the multiple erosions. In the first place it is usually single; then its site in the vast majority of cases is limited to a restricted area of the stomach's surface; over long periods it shows little or no tendency to heal but,

Received for publication, June 25, 1937.

at the same time, it may show an equal disinclination to extend. It remains a callous, indolent, unhealing ulcer. The peculiar and constant localization of the lesion to the lesser curvature, some 2 to 3 inches proximal to the pylorus, has been given special etiological significance, and it has been correlated with an assumed special exposure of this part of the stomach—the "gastric pathway"—to trauma and friction from the gastric contents, but there is little in the way of fact to aid the supposition that this is a causal factor. The greater curvature in this segment must participate equally in such traumata and the same anatomical peculiarities and yet it escapes the supposed consequences. The thrombosis of small vessels was the cause suggested by Virchow;

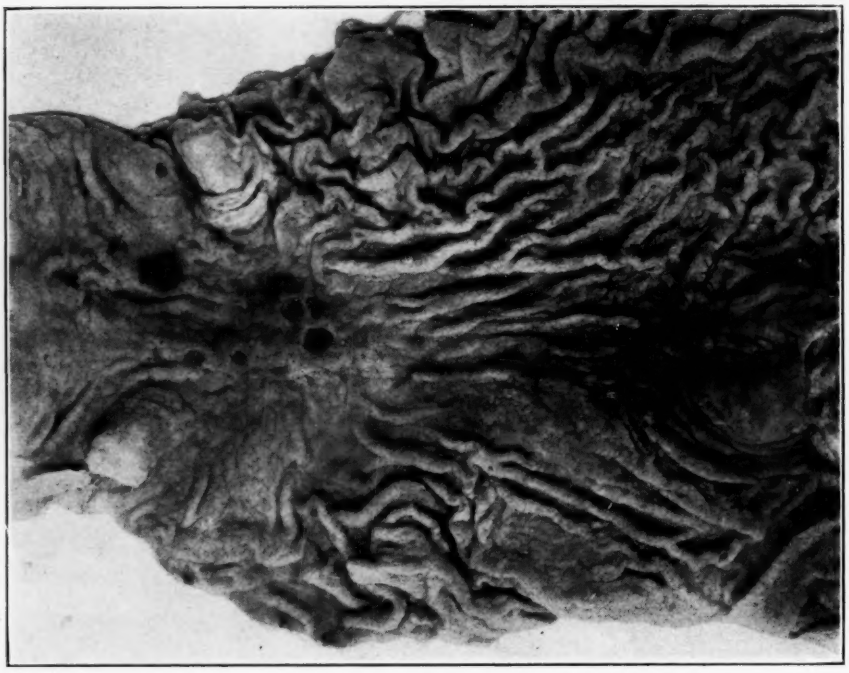

Fig. 1.—Superficial and hemorrhagic erosions in the stomach of a man dying from uremia.

but no convincing reason for such thrombosis has ever been forthcoming, and, moreover, the gastric anastomoses are so free that a limited thrombosis would be without effect. Further, no explanation has been advanced to show why a lesion resulting from such thrombosis should remain so long unhealed. True it is that extensive vascular derangement, even including complete obliteration, is to be demonstrated in the floor of the chronic ulcer, but here it is clear that such changes are the result of the ulcer and not its cause. On the experimental side it has been shown that the excision of areas of mucosa is not followed by ulceration but by healing, which is usually accomplished within the space of about ten days. When, however, as Bolton showed, the acidity of the

gastric juice is artificially increased, the healing of these lesions is delayed and chronic ulcers are produced which are similar in structure to those found in man. Constricting the pylorus has a similar effect, so that the prolonged action of acid may be regarded as a factor similar in effect to hyperacidity. It is clear, therefore, that the acid gastric juice is an important accessory factor in the production of an ulcer and in maintaining the condition of chronic ulceration: but when we have said this we have exhausted most of our exact knowledge of the part which it plays and we have left unanswered the question of why the acute ulcer so often heals, and only on occasions becomes chronic; why the chronic ulcer sometimes heals; and why the surgical lesion left after the excision of a chronic ulcer will generally heal. The main

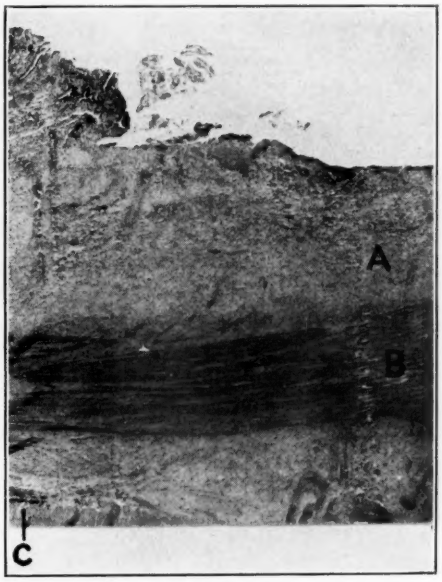

Fig. 2.—Acute ulcer. *A*. Edematous Submucosa. *B*. Circular muscle. *C*. Longitudinal muscle. (×12.)

causal factor of chronic ulcer is still unknown. It was thought at one time that an abnormal hyperchlorhydria was associated with gastric ulcer and that this might be a causal factor, but more recent investigation has dispelled this belief. The presence of an ulcer, if it cause pyloric spasm, certainly has the effect of increasing the concentration of hydrochloric acid and in prolonging its action in the stomach, as the prolonged and mounting curve of the fractional test meal will show, so that in such cases a vicious circle is introduced and the experimental requirements for chronic ulcer production are fulfilled. Once the chronic ulcer is established, the acid gastric secretion is of unquestionable importance in retarding or annulling efforts at healing and it must be held responsible, to some extent at least, for the absence of healthy

granulations which is such a striking feature of the chronic ulcer. The high H-ion concentration inhibits cell division, and the activity of angioblasts and fibroblasts in repair. The proof of this lies in the beneficial results which in a proportion of cases may be obtained from alkali therapy.

We therefore reach this position: that given some primary factor which is responsible for the ulcer formation, the gastric acidity is an important secondary factor in maintaining the lesion. Of the primary factor or factors we are still in ignorance. Of recent years great interest has been aroused by the work of Harvey Cushing upon the effects of hypothalamic stimulation upon the gastric function. Cushing finds that in certain instances this results in ulcer production and he puts forward the view that a center in the diencephalon is responsible for stimuli conveyed along tracts through this region to the vagal nuclei whence parasympathetic fibers are distributed to the stomach regulating acid secretion and motility. Direct stimulation may set up hyperacidity and spasm of the pyloric portion of the muscle with resulting areas of local ischemia and infarction leading to ulceration (Cushing, 1932, see also Fulton, 1934). This interesting work, which revives the discarded neurogenic theory of Rokitansky in another form, is pushed further so as to embrace the observation that the incidence of gastric and duodenal ulceration is increasing in modern life and the suggestion is made that it is a penalty of the strain which modern life imposes upon the nervous system. Cushing believes that the center responsible for the neurogenic mechanism described is readily stimulated by psychic impulses from the cortex. Such a view has the merit of providing a basis for the initial lesion and for the conditions which prevent healing and lead to chronicity. It rests, however, too much upon speculation based upon limited, thought brilliant, experimental results to warrant its present application to the wide field of gastric ulceration, although it would appear to bear very definitely upon a limited number of cases within that field.

MORBID ANATOMY

The study of gastric ulcers which follows is based almost wholly upon surgically removed material which alone is suitable for accurate histological study. Most of the author's material has been received in the form of a portion of the stomach, including the ulcer-bearing area, removed by partial gastrectomy.

The routine treatment of the specimens has been to distend them gently with cotton wool, without opening, and thereafter to fix them for twenty-four hours in 10 per cent formol-saline. When fixation is completed the specimen, which is now hardened in its natural shape, is opened by slitting along the greater curvature. The interior is examined and as much of the unaffected portion of the wall as may seem desirable is removed so as to allow a clear view of the ulcer and the interior

of the stomach which is either photographed or roughly drawn. Blocks are then removed for sections and their position is marked upon the key drawing or photograph. By this technique only a minimum of distortion occurs. Sections are stained chiefly with hematoxylin and eosin, iron hematoxylin, van Gieson's stain and Masson's aniline-blue ponceau, the latter being especially valuable for the study of the relationships of muscle and fibrous tissue.

As seen by the pathologist the fully developed ulcer is usually of the chronic type. The acute ulcer, which only rarely comes his way in surgical material, is distinguished by its lack of fibrous tissue reaction, its tendency to have terraced edges, its thin floor. Microscopically it again shows a lack of fibrous replacement of the coats of the stomach so that the ulcer, provided it has not perforated, is floored by muscular tissue (Fig. 2).

As judged from surgical material, chronic ulcers of the stomach are commoner in the male than in the female; in my own series, drawn from such a source, 72 per cent occurred in the male and 28 per cent in the female: on the other hand the acute type of ulcer which gives rise to hemorrhage is commoner in females than in males. The age of incidence in chronic ulcer is impossible to determine, since it is only after some years—sometimes decades—of suffering that the patient comes to operation. The age *at operation* varies extremely, the earliest in my series was twenty and the oldest eighty-eight. The chronic ulcer is usually single, but in about 2 per cent of cases more than one may be present. As Stewart (1929) has pointed out, it is more common to find a subacute or acute second ulcer, or even multiple ulcers of the latter type, associated with a chronic gastric ulcer than it is to find a second truly chronic ulcer. The usual site for ulcers is the lesser curvature, between 2 and 4 inches from the pylorus, and usually occupying a saddlelike position upon it. Stewart has investigated the distance of the lesion from the pylorus with great thoroughness and gives the following figures from his surgical material: *Pyloric canal:* 3.5 per cent. *1 to 2 inches from pylorus:* 22.4 per cent. *2 to 3 inches:* 34.1 per cent. *3 to 4 inches:* 29 per cent. *4 inches:* 10.6 per cent.

The chronic gastric ulcer, when fully developed and viewed from the inside of the viscus, presents a sharply punched-out and generally rounded crater with somewhat overhanging edges and a congested angry-looking base which, however, is often covered by a thin greyish layer of necrotic debris. The size of the crater varies from about one-eighth of an inch up to an inch or more: those of very large size may be suspected of malignancy. On the peritoneal side the peritoneum is thickened, edematous and whitish, and it is very common to find an enlarged lymphatic gland—the "sentinel gland"—embedded in the gastrohepatic omentum in close juxtaposition to the base of the ulcer.

For descriptive purposes gastric ulcers may be classed in order of severity into (1) those without much fibrosis or distortion, (2) those

with considerable fibrosis and distortion, and (3) those involving other organs. A small ulcer of the first group is illustrated in Fig. 3. There is little or no change in the configuration of the stomach and little induration of the surrounding gastric wall, even though in the case illustrated the clinical history suggested a long duration. In microscopical section the general histology of the chronic ulcer is illustrated in Fig. 4. The mucosa overhangs the edge and ceases abruptly, being replaced by some necrotic debris which forms the floor of the ulcer. The muscular coats end more or less abruptly and a mass of hard, relatively avascular, sclerosed fibrous tissue completely interrupts the continuity of the coats of the stomach beneath the area of ulceration. On its sur-

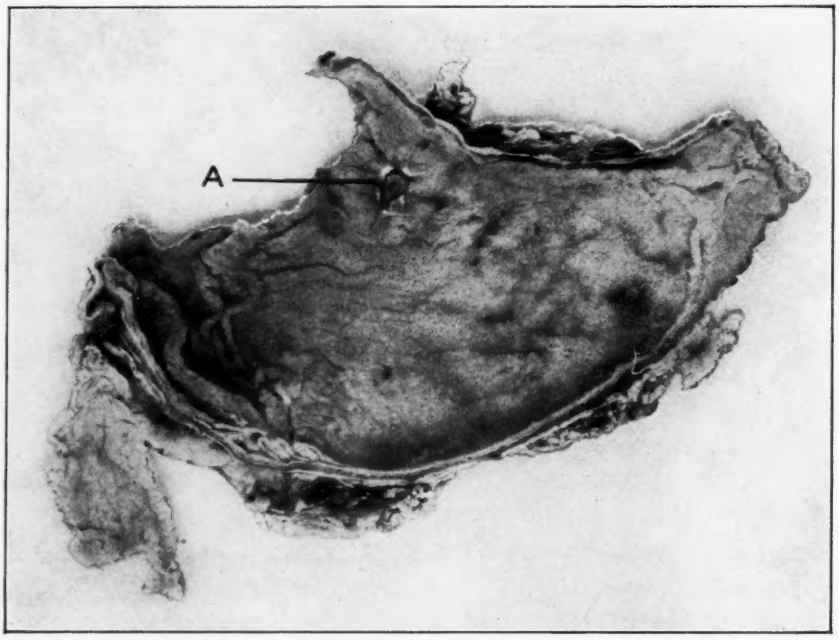

Fig. 3.—Small chronic ulcer. *A*. Ulcer, which is on the lesser curvature but appears on the posterior wall owing to the specimen being opened out.

face this fibrous plug appears to be undergoing a slow necrosis, as evidenced by the presence of a layer of necrotic tissue which takes acid stains strongly, and beneath this higher magnification shows some superficial fibroblastic and leucocytic reaction. On the whole, however, and generally, there is a remarkable absence of evidence either of the process of extension or of that of repair. If we examine the edges of the ulcer, we find the submucous coat is thickened and often edematous for a short distance on either side. Newcomb (1925) has drawn attention to the fusion which tends to occur between the muscularis mucosae and the subjacent muscularis if healing of the ulcer takes place. On the other hand, when a carcinoma is extending in the stomach wall, the malignant cells tend to infiltrate along this tissue plane and to split

SURGERY
VOL. 2, NO. 5, NOV., 1937

Fig. 4.—Low power section of a chronic ulcer. Stained by van Gieson's method. (×3.5.)

off the mucosa and its muscularis from the underlying circular muscle (Fig. 5). To the writer the most characteristic feature of the chronic ulcer is the complete destruction of the muscular coat at its base, so that the whole thickness of the ulcer floor—from lumen to peritoneum—is composed of fibrous scar tissue. The impression which the study of such lesions strongly creates is that though the ulcer may remain static, in point of size, over considerable periods of time, yet a ceaseless inflammatory reaction of low grade is maintained with continued fibroblastic proliferation in its base and often a continued exudation of inflammatory edema fluid into the areolar tissues of the stomach wall in the neighborhood. The fibroblastic reaction is, however, insufficient to diminish the scope of the ulcer and merely balances the constant slow

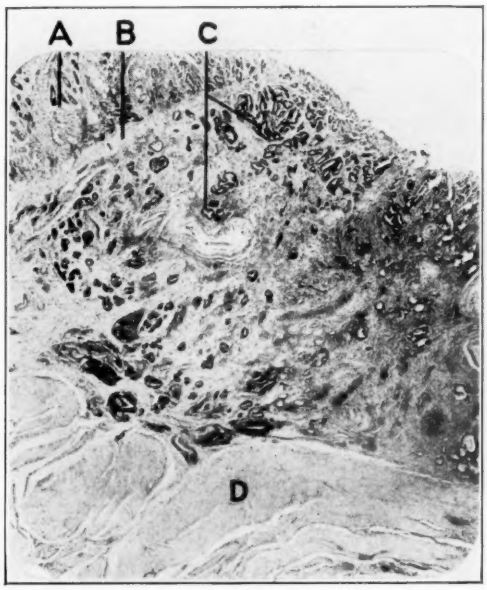

Fig. 5.—Early carcinoma spreading along the submucosa and splitting off the muscularis mucosae from the subjacent muscle. *A*, Mucosa. *B*, Muscularis mucosae. *C*, Carcinoma cells. *D*, Circular muscle. (×12.)

necrosis which goes on at the surface. At the same time the mucosal proliferation is inhibited and no extension of the mucosa into the crater of the ulcer can take place as long as healthy granulation tissue, upon which it only can engraft itself, is absent.

In the second grade of severity come those ulcers in which there is considerable distortion of the organ. This results from the spread of fibrosis beyond the stomach wall. The extent of the associated fibrosis is extremely variable and is difficult to correlate with any single causal factor. Certainly, as far as one is able to judge from clinical histories, it is not wholly, or even in the main, dependent upon duration. It is common to find well-marked fibrotic changes in the submucous coat in the area about the ulcer crater, but this sclerosis may be distributed

eccentrically, partly as a result of healing in one direction with spread in another, so that in a saddle ulcer it may affect one wall much more than the other. This is seen in a moderately developed condition in Fig. 6 which shows a partially healed ulcer of the lesser curvature with a well-marked fibrosed scar in the region of maximum change. Here there is also a considerable edematous infiltration of the submucous coat which is much more marked in the posterior wall and in which active fibroblastic proliferation is going on. Actual distortion is most usually produced by the spread of fibrosis into the gastrohepatic omentum. Figs. 7 and 8 show a common result of this fibrosis, which causes

Fig. 6.—Sagittal section of the pyloric portion of the stomach at the site of a partially healed ulcer of the lesser curvature. There is a dense scar (*A*) at the site of the ulcer above which the sentinel gland is seen lying in the gastrohepatic omentum. There is also considerable fibrosis and edematous thickening (*B*) which in this case extends well down onto the posterior wall.

a puckering of the stomach wall and an approximation of the coats of the viscus on either side of the ulcer so as to produce a decided incisura upon the lesser curvature which becomes progressively deepened. In the first case illustrated the duration of the condition had been only 18 months, but in another and almost identical specimen with a similar degree of distortion the history of gastric derangement was as long as thirty years.

By the spread of fibrosis and edema towards the greater curvature, the condition of hourglass stomach (Fig. 8) is brought into being, and

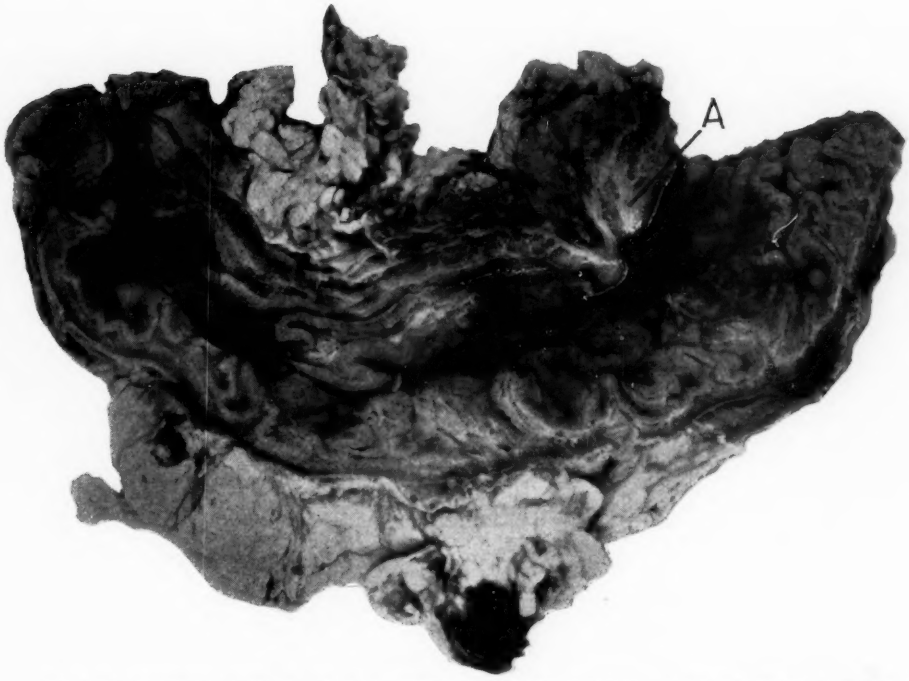

Fig. 7.—Coronal section of a stomach with the anterior wall removed. There is an ulcer on the lesser curvature which is causing complete destruction of the muscular coat and considerable puckering and indentation of the lesser curvature.

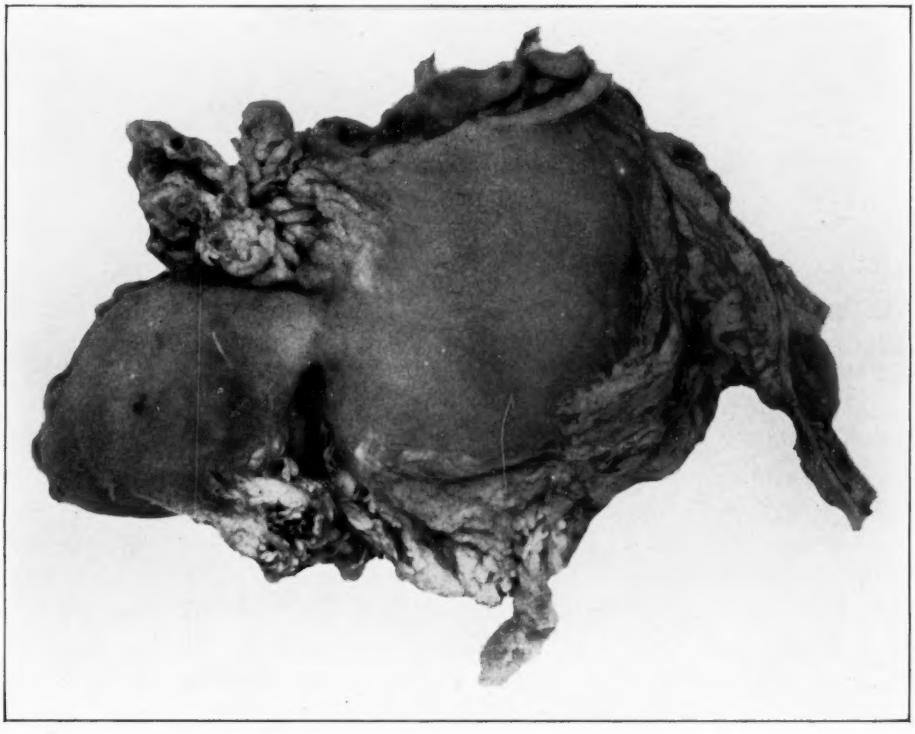

Fig. 8.—Unopened stomach seen from the front: there is a well-marked hourglass constriction: note the incisura on the greater curvature.

this is often assisted by spasm of the circular muscle fibers radiating from the ulcer region, which produces a complementing incisura on the greater curvature and tends to complete the hourglass condition. In extreme cases the whole neck of the constriction is fibrous and there is a complete organic stricture, but in the less severe grades spasm is a decided contributory feature. An extreme degree of distortion from fibrosis is illustrated in Fig. 9 which shows a very callous ulcer with an extragastric pocket which is actually encroaching upon the lesser curvature from without: there is in addition marked edematous infiltration and fibrosis of the submucosa and the omentum, and both spasm and hypertrophy of the muscle in the vicinity.

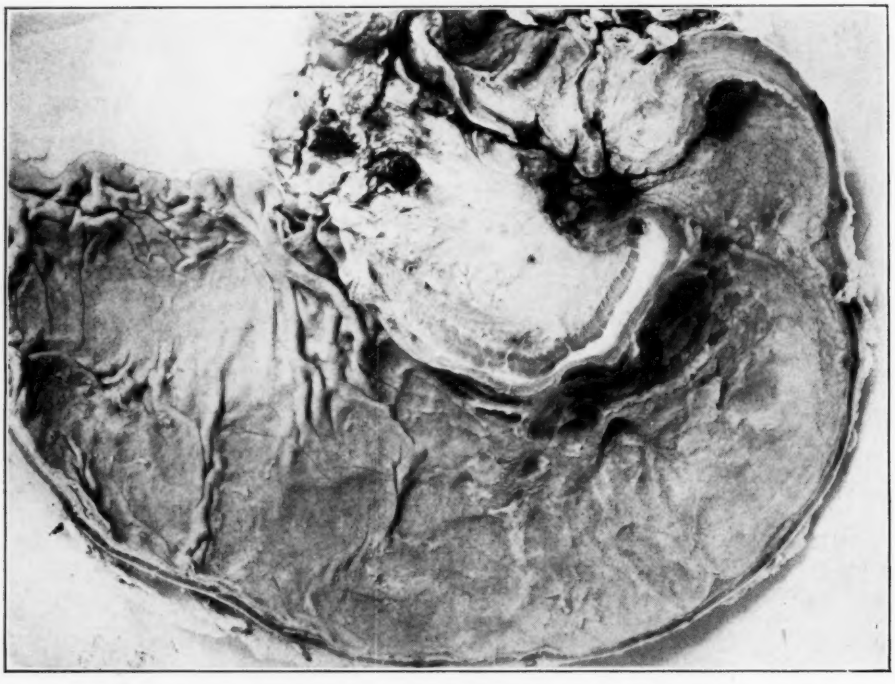

Fig. 9.—Chronic ulcer penetrating the gastrohepatic omentum and actually extragastric. Note the enormous edematous infiltration of the stomach wall and the thickening of the muscular coats.

Thirdly we have the more extensive and chronic types of ulcer which undergo considerable extragastric extension and involve related organs, more especially the pancreas and the liver. Fig. 10 shows a large ulcer penetrating the liver deeply and Fig. 11 an ulcer which is penetrating to the pancreas, the white nodular tissue of which is well seen in the ulcer floor. Such involvement may set up chronic pancreatitis. It is more especially in ulcers of this sort that the erosion of large vessels occurs giving rise to grave and sometimes fatal hemorrhage.

The Complications of Chronic Gastric Ulcer.—The important complications are (a) perforation, (b) hemorrhage, (c) malignancy. Both

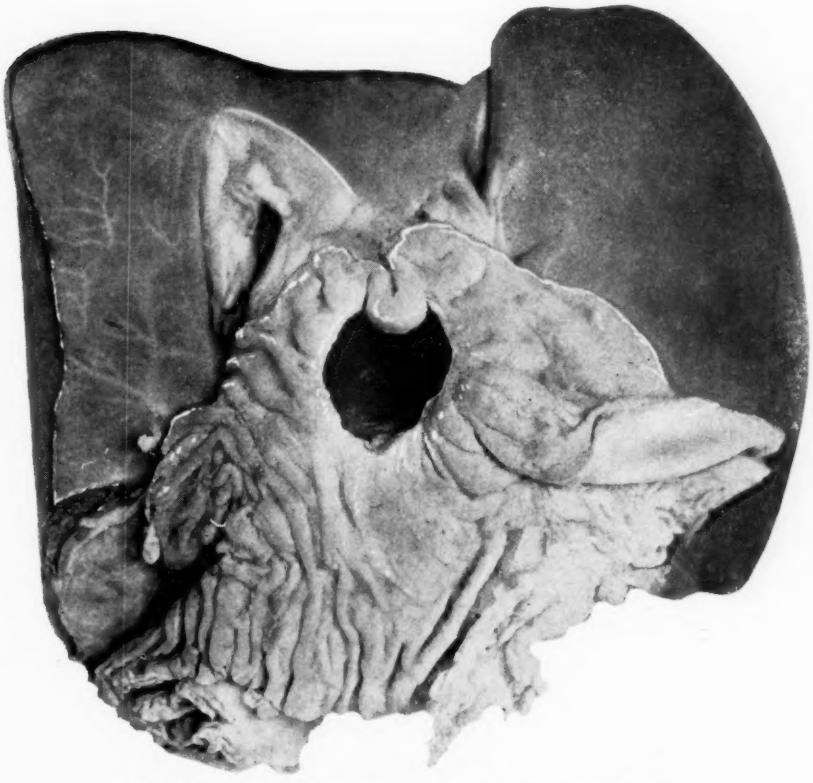

Fig. 10.—Ulcer penetrating to liver. (P.M. specimen.)

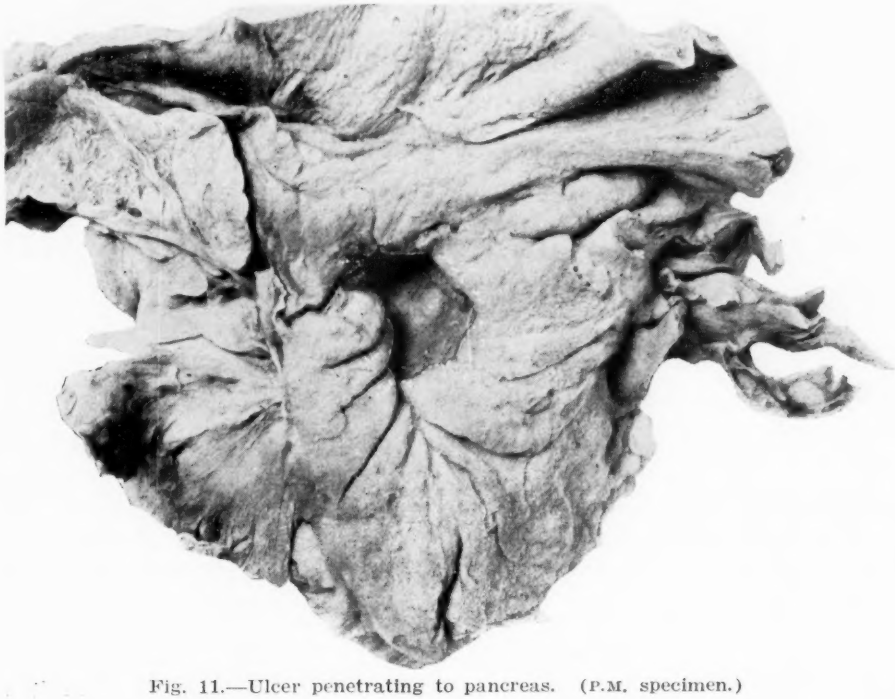

Fig. 11.—Ulcer penetrating to pancreas. (P.M. specimen.)

perforation and hemorrhage are commoner in the acute type of ulcer than in the chronic type, since in the latter the perforation is to a large extent guarded against by adhesions and the chances of hemorrhage are lessened by the protective endarterial changes which are usually

Fig. 12.—Endarteritis obliterans of vessels in the base of a chronic ulcer. (×12.)

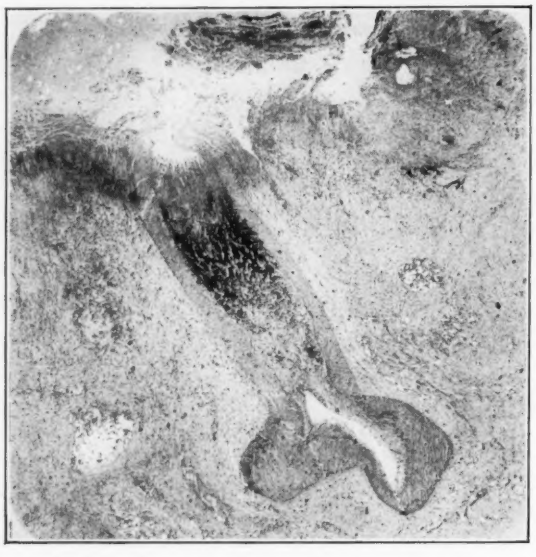

Fig. 13.—Thrombosis of an eroded artery at the base of a chronic ulcer.

developed. The acute type of ulcer is responsible for most of those cases of profuse gastric hemorrhage which occur in young women, especially those who are the subjects of anemia. When hemorrhage occurs from a chronic ulcer, it is apt to be more dangerous and intractable for reasons which we shall explain. In any case amongst chronic ulcers it is those which are associated with the more clamant symptoms, in-

dicating an actively progressing lesion, which offer the greatest risks both from hemorrhage and from perforation.

The effect of the slow advance of an ulcerative process upon the larger vessels in its vicinity is to set up a process of occlusion by endarteritis and endophlebitis. These changes, which are irritative in origin and protective in function, are extremely common and indeed are characteristic of the histological findings in the tissues at the base of any chronic ulcer (Fig. 12). Often the process is completed by thrombosis and at a later date the organization of the thrombus, so that by the time the arterial trunk is opened it is no longer permeable (Fig. 13).

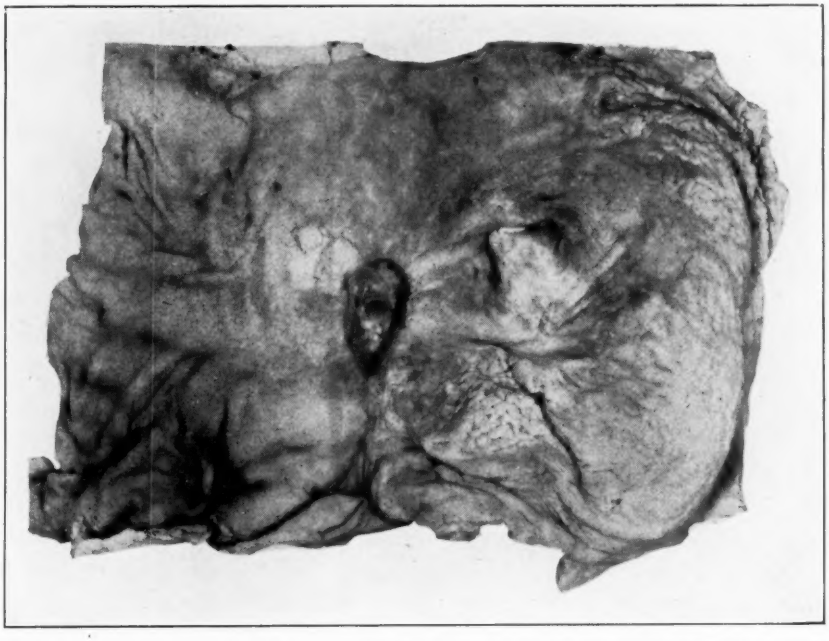

Fig. 14.—Aneurysm of the left gastric artery at the base of a chronic ulcer. A postmortem finding, rupture not having occurred. The aneurysm is seen bulging into the floor of the ulcer.

At times, however, the reaction fails, either on account of the rapidity of the arterial ulceration or from causes which are unknown, and relatively large and unoccluded vessels may be invaded. When this happens there is a tendency for the artery to become aneurysmal and to rupture into the base of the ulcer (Fig. 14). In such cases the hemorrhage which results is apt to be particularly intractable for the reason that the artery is held in rigid sclerous fibrous tissue and is not only incompletely severed, the rupture being lateral, but is also prevented from retracting by the adherence of the fibrous tissue in which it is embedded. The vessels most commonly involved are the right and left gastric (coronary) arteries of the stomach, or the splenic artery which may be

eroded by an ulcer penetrating the posterior wall of the lesser curvature and involving the pancreas, at the upper margin of which this vessel lies.

Perforation.—This, as we have already said, is commoner in the acute than in the chronic type of ulcer and when it occurs in the latter, it is due to unusually active progress and is therefore most liable to appear in those ulcers which are giving rise to active symptoms. The actual perforation is due to the rupture of a necrotic patch in the base of the ulcer which may be either central or eccentric and produces a circular hole situated as a rule on the anterior wall of the viscus. The figures collected by Stewart, and including his own extensive series, show that perforation of the anterior wall is about six or seven times as common as perforation of the posterior wall. The same observer also points out that it is most frequently ulcers of the pylorus or prepyloric regions which perforate; in his series this complication being twice as common in ulcers which lay within two inches of the pylorus as it was in those situated more proximally.

The stomach contents are in most cases from a practical point of view sterile. They cannot be regarded as bacteriologically sterile, but organisms are few in number and pathogenic forms neither frequent nor virulent: in consequence the peritoneal shock and peritonitis which follow upon perforation are traumatic and chemical at their inception, and it is only after a period, which has been put at about twelve hours, that a bacterial flora begins to establish itself in the peritoneum and an infective peritonitis sets in. This explains the supreme influence which early operation has upon the prognosis.

Malignant Change.—The frequency of this complication in gastric ulcer has been actively debated and widely divergent views have been expressed. Our own view as a result of pathological, clinical and histological studies, (Dible, 1925) is that in only a small proportion of cases—probably about 5 to 6 per cent—is carcinoma to be attributed to ulcer. The development of malignancy unquestionably occurs—as it may occur in any chronic unhealing lesion—and it may *a priori* be anticipated with greater frequency in a lesion constantly exposed to infection and the irritation of the gastric juice, but the examination of a very large number of gastric ulcers and cancers has convinced us that there can be no hesitancy on the part of an experienced pathologist in recognizing malignancy when it is present and, further, that the signs of pre-existing ulcer—always supposing that the malignant disease has not advanced to a stage at which histological criteria are masked—are in all but an insignificant minority of cases readily recognizable. The chronicity and long history of gastric ulcer, the short history of carcinoma; the predilection of ulcer for a site 2 to 3 inches from the pylorus and of cancer for the juxtapyloric position; the earlier age of onset; together with the histological criteria, indicate that in general

SURGERY
VOL. 2, NO. 5, NOV., 1937

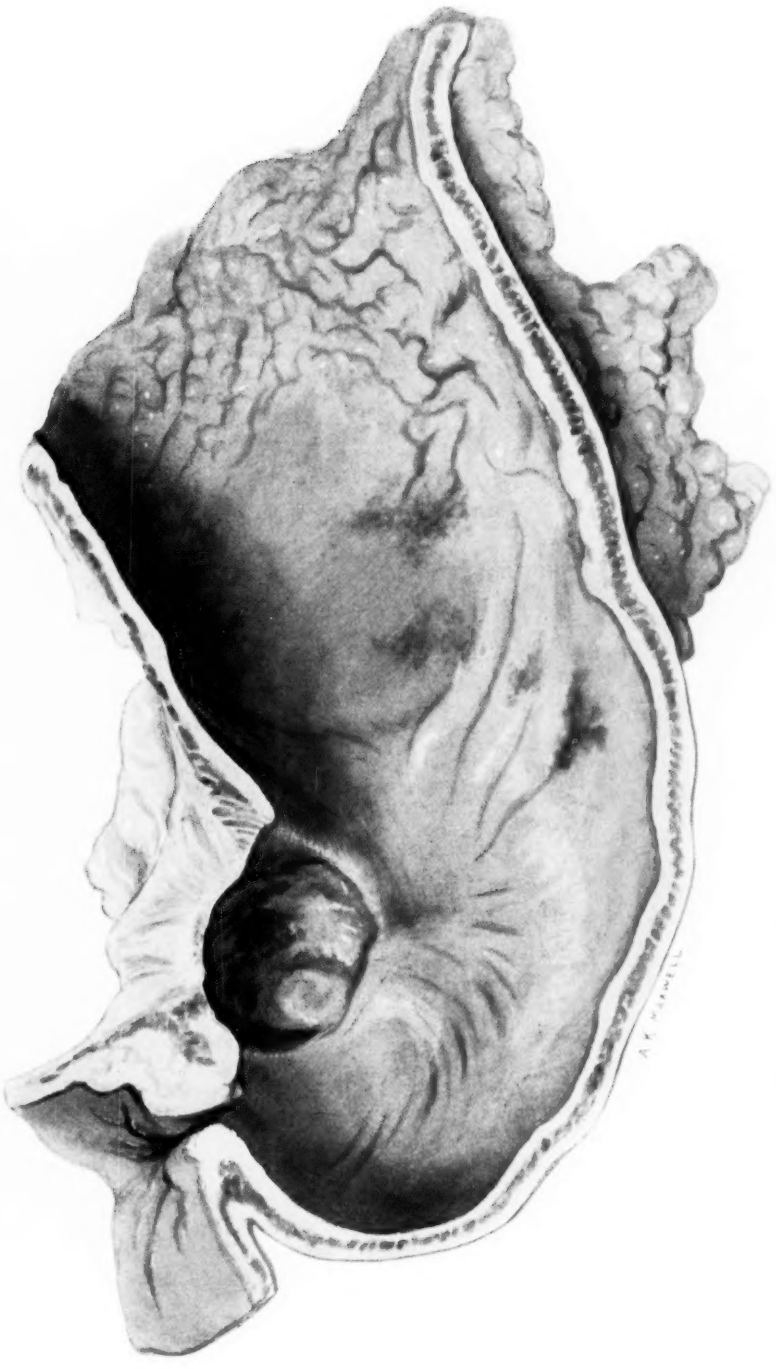

Fig. 15.—Ulcer-cancer. There is nothing in the naked-eye appearance to denote malignancy.

the diseases are distinct and independent. Briefly put, the histological criteria of ulcer are: the complete destruction of the muscular coat and its replacement by fibrous tissue; the well-developed endarteritis and endophlebitis in the juxtaposed vessels; and the presence of simple scarring as opposed to malignant stroma reaction in the stomach wall: all of these are features of chronic ulcer. Some of these changes are also produced by the action of a malignant neoplasm, especially where this is of a type productive of an abundant stroma, but where all data are considered, clinical and pathological, the number of cases in which the balance of evidence points to malignant disease having arisen in a chronic ulcer is but small, and in our experience of the order of 5 to 6 per cent. Finally, it should be emphasized that the observer must not be led astray by superficial appearances and the mere semblance of ulcer, which it is very obvious may occur with the greatest readiness in the ill-resisting tissue of a neoplasm.

A typical example of ulcer-cancer is illustrated in Fig. 15.

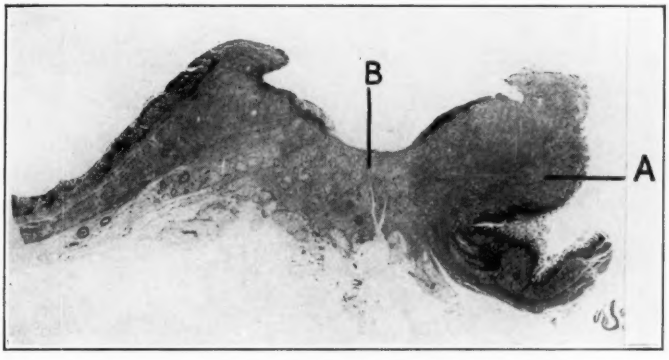

Fig. 16.—Microscopical section of ulcer-cancer illustrated in Fig. 15. *A*. Duodenal mucosa. *B*. Fibrous tissue permeated by cancer cells. (×2.)

This patient was a male, aged twenty-nine. There was a history of gastric symptoms of about twenty years' duration which were latterly more severe and accompanied by almost constant pain. Partial gastrectomy was performed by Professor A. H. Burgess, of Manchester, and revealed a chronic ulcer of the lesser curvature close to the pylorus. A large section in the coronal plane (Fig. 16) shows the general features of ulcer under the lower power, but under the higher magnifications extensive infiltration with cancer cells is seen and a secondary deposit was present in a sentinel gland close to the base of the lesion. The interruption of the muscular coat by a fibrous cicatrix was complete, and it is important to note that considerable areas of this scar tissue showed an entire absence of cancer cells. The vessels showed moderate endarteritis. The growth was a rather anaplastic columnar-celled carcinoma giving rise to a moderate stroma reaction.

Healing.—The majority of acute ulcers heal; only a certain proportion become chronic, and a considerable number of these heal. Exact figures are impossible to obtain, but the regularity with which cure follows upon the satisfactory and persistent treatment of acute ulcer

with hematemesis points to the eminent curability of the lesion at this stage. From the morbid anatomical point of view ulcers which do not involve the muscle will heal completely, even to the regeneration of the muscularis mucosae and will therefore fail to leave recognizable scars or, at the most, will leave only very trivial alterations not easy to detect. From the rarity of scars which involve only a portion of the muscular coat, it must be rare for acute ulcers (as distinct from erosions) to heal at the stage of partial muscular destruction: so that when once the muscularis has been attacked it would seem that the ulcer either passes on to complete muscular destruction with perforation or goes through the stage of being a chronic ulcer before healing takes place. The presence of scars which have a complete epithelial covering

Fig. 17.—Healed ulcer. *A*. Muscle remnants. *B*. Fibrous tissue. *C*. Artery showing persistent endarteritis. (×12.)

over a fibrous cicatrix, which wholly interrupts the continuity of the muscularis, is a common finding at postmortem examinations and represents a healed chronic ulcer.

The possibility of healing in a chronic ulcer would appear to be largely governed by the amount of distortion which it has caused. It is difficult to imagine a gross and callous lesion such as that depicted in Fig. 9 ever healing, while there are no reasons to doubt that a small ulcer such as that depicted in Fig. 3, in which there is no anatomical obstacle to epithelialization might, given favorable circumstances, heal.

The healing ulcer is recognized by a clean floor devoid of sloughs and a generally sloping margin down which a thin single layer of epithelium is creeping onto the ulcerated surface. The evidences of acute reaction are at the same time reduced and the edema which is partly responsible

for the overhanging edges of the typical ulcer subsides. The fibrous tissue in the floor also becomes less edematous and better organized and contracts, often to a marked degree, so that the final cicatrix is almost trivial when healing is complete (Fig. 17). As this matures the epithelial covering becomes more complex and in the healed state there is a certain restoration of the normal glandular structure of the mucosa, which however always falls short of perfection, since it is usually rather flattened and there is no regeneration of oxyntic cells. It is also not uncommon to find that the partially obliterated arteries which are so common in the gastric ulcer persist after healing is complete.

Taylor (1927) and Stewart point out that it is quite common for areas of the regenerated epithelium to undergo a form of heteroplasia leading to the production of goblet cells and a superficial resemblance to intestinal epithelium.

My thanks are due to the *British Journal of Surgery*, the proprietors of which have kindly allowed the reproduction of many illustrations from the paper published therein in 1925.

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THE VALUE OF GASTROSCOPY IN DIAGNOSIS AND SURGICAL TREATMENT OF CHRONIC GASTRODUODENAL ULCER

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THE following discussion on the value of gastroscopy in diagnosis and treatment of chronic gastroduodenal ulcer is based essentially on the observation of 66 patients with gastric ulcer, in whom 137 gastroscopies were carried out. Thus, on the average, every patient suffering from gastric ulcer had 2 gastroscopies done; in reality, naturally, many patients had only 1 gastroscopy; whereas, others had from 5 to 13. About the same number of patients with duodenal ulcers had gastroscopic examinations, but exact figures are not available, because it is certain that many such cases had gastroscopies without my knowing it. From 1921 to 1932, a large number (about 120) of gastric ulcers were examined by the old rigid Schindler gastroscope. They are not included in the following discussion.[1]

The section on postoperative stomach is based on the findings in 117 gastroscopies carried out with the flexible gastroscope in patients who had undergone some operation because of gastroduodenal ulcer.

The paragraph on gastrophotography is based upon 76 examinations with the gastrophotor and on 96 gastroscopic examinations in which the rigid gastroscope with Hennings camera attachment was used. That on radiography refers to over 4,000 x-ray relief examinations carried out with Sielmann, Munich, from 1926 to 1934. In 360 cases examined after the invention of the flexible gastroscope, comparison with the gastroscopic picture was possible.

It is assumed that the reader does not fully know the rapid development of modern gastroscopy since the invention of the flexible gastroscope; therefore, a few brief statements on the technical part shall be given.

The flexible gastroscope is a round tube, consisting of the lower flexible and the upper rigid parts. The lower flexible part, which bends during the examination along the posterior wall of the stomach, remains flexible and bent during the whole examination. Its upper end lies still above the hiatus esophagus, even if the instrument is introduced to its full length. The flexible part is elastic and is guided by an elastic rubber tip. Above this rubber finger is a very bright electric lamp which illuminates the stomach and the objective which collects the rays coming from the gastric wall and which deviates this picture into the axis of the gastroscope. The sharp and bright picture then is observed

Received for publication, December 18, 1936.

through the ocular. This instrument is introduced into the stomach of the patient in his left side position exactly like a simple Ewald tube, but after a careful local anesthesia of the throat. This makes the procedure easy for any reasonable, cooperative patient. Because of the small diameter of the instrument (7.5 mm.) one frequently experiences that the patient not only is willing to allow the physician to observe the course of the ulcer by repeated gastroscopies, but even desires frequent repetition of the examination. The mode of introduction has to be learned; however, it is not difficult. In contrast, the orientation in the cavity of the stomach and the interpretation of the seen picture are very difficult. Gastroscopy is not like other endoscopies. The correct interpretation of pictures in functionally so important an organ is only possible either by a specialist in internal medicine or by a surgeon well trained in general surgery. Both must have a good knowledge in pathologic anatomy.

At the outset it should be stated frankly that in ulcer gastroscopy has not the undeniable outstanding value that it has in the two other major diseases of the stomach, namely, carcinoma and chronic gastritis. The reason is that many ulcers cannot be seen, while carcinoma and the various forms of chronic gastritis almost always are seen. After this concession, the author will attempt to show that in chronic gastroduodenal ulcer, gastroscopy is of great value, especially to the surgeon.

The discussion will be subdivided as follows: (1) the gastroscopic findings in chronic gastroduodenal ulcer will be described; (2) the differential diagnosis of the various types of gastric ulcerations will be discussed; (3) the gastroscopic findings in postoperative stomachs will be described; (4) a short comparison between gastroscopy, gastrophotography, and x-ray examination in ulcer will be given; and (5) the summary briefly will show the value to the surgeon of gastroscopy in gastroduodenal ulcer.

GASTROSCOPIC FINDINGS IN CHRONIC GASTRODUODENAL ULCER

1. *General Disturbances in the Stomach of Patients Suffering From Gastroduodenal Ulcer.*—Sometimes by gastroscopic examination the stomach of patients suffering from chronic gastroduodenal ulcer, except for the ulcer itself, appears to be normal. In many cases, however, changes are observed which are of practical importance. Some of these characterize the "ulcer stomach." They should be subdivided into: (a) disturbances of motility, (b) disturbances of secretion, (c) disturbances of circulation, and (d) inflammatory changes.

A. *Disturbances of motility:* Often it is difficult for a beginner to perform gastroscopies in patients suffering from ulcer because of the increased spasticity. While usually the passage through the esophagus is easy when speedily carried out, difficulties begin as soon as the instrument touches the posterior wall. A marked resistance is felt render-

ing it impossible to push the instrument forward and into the lower depths of the stomach. This resistance is due to a spasm of the gastric muscularis. It may be so marked as to grasp the instrument, but it subsides slowly. In a patient who had six gastroscopies, such a spasm complicated each attempt to find the suspected ulcer. By diverting the patient's attention and conversing with others in the room, it always became possible to push the instrument forward because the resistance suddenly subsided. This sudden relaxation of the gastric wall is very common in ulcer. Localized spasms near the ulcer or distant from it were frequent during the era of the rigid gastroscope. They have disappeared almost completely since the use of the flexible gastroscope. This fact, also noted by Moutier,[2] has found no adequate explanation.

B. *Disturbances of secretion:* While the mucosa of the normal, gastritic, and carcinomatous stomach can generally be easily observed, this may be difficult in ulcer. A few moments after the introduction of the instrument, abundant secretion may begin, so that the mucosa rapidly becomes covered with secretion mixed with air bubbles. The search for the ulcer becomes very difficult, and the objective of the gastroscope needs frequent wiping by turning it to the posterior wall. This abnormal irritability is often still present when the ulcer has been healed for long months. Because of this supersecretion, the gastroscopic examination in these cases must be made rapidly, and consequently it is frequently difficult to demonstrate the ulcer to onlookers.

C. *Disturbances of circulation:* These are the most frequent and most important ones. Of all gastroscopists, however, only Chevalier Jackson and Borland have confirmed these observations. It is easy to see these changes if patients with stomach ulcers have repeated gastroscopies. Three lesions may be seen which are related to each other: mucosal hemorrhages, pigment spots, and hemorrhagic erosions. They are often seen years after the complete healing of an ulcer, and can mean, like persisting irritability, that the stomach still is ready to develop a new ulcer.

The mucosal hemorrhages, which are easily demonstrated, lie in normal, uninflamed mucous membrane. They appear as dark red patches and are pinhead to pea sized, round or linear. Frequently they are seen one centimeter above the angulus on the lesser curvature, i.e., at the most common site of gastric ulcer. Sometimes many of them lie in a row along the lesser curvature from the cardia to the angulus. If one gets the opportunity to observe such a stomach once weekly, he will find that these hemorrhagic spots are changed into brown pigment spots. These latter often are not as round as the hemorrhages, but starlike. Frequently pigment spots are found at the first examination without any hemorrhage present or together with hemorrhages.

Occasionally a hemorrhage develops into a hemorrhagic erosion. This is the hemorrhagic erosion of the older pathologists. (Fig. 1.)

Recent workers have contended that it does not exist. It is impossible to overlook them, however, if regular gastroscopic examinations over long periods of time are made of stomachs with ulcers. The erosion surrounded by a dark red area usually is not very deep; its color is gray or reddish gray. This hemorrhagic erosion seems to be the acute stage of the chronic ulcer; therefore, the expression "preulcerous conditions" may be used for the changes described in this paragraph.

D. *Inflammation in the ulcer stomach:* Gastric ulcer may be found in an apparently normal mucosa. In many instances, the adjacent surroundings of the ulcer are inflamed, swollen, edematous, or thickened. Inflammation of the whole gastric mucosa occurs, although rarely. Hard to explain are those cases in which the neighborhood of the ulcer is normal while a distant area is markedly inflamed.

In duodenal ulcer sometimes no sign of inflammation can be found, notably not the so-called ulcerative antrum gastritis. This serious dis-

Fig. 1.—Hemorrhagic erosion. Two large brown pigmented spots are seen in the anterior wall. A small erosion surrounded by a hemorrhagic halo lies in the lesser curvature. (The black circle at the edge of gastroscopic pictures indicates the position of the objective in left side position of the patient.)

ease, though rare, exists, and its characteristic changes are easily recognized gastroscopically, but it is not found in association with duodenal ulcer. Neither has gastritic ulceration, even when checked by repeated gastroscopies, been observed to develop into true chronic ulcer. The theory of the gastritic origin of gastric ulcer (Konjetzny, Hurst, Faber) cannot be corroborated by gastroscopic observations, because: (1) too often ulcer occurs in a perfectly normal mucous membrane without any evidence of accompanying gastritis; and (2) gastroscopically, those ulcers of the frequent ulcerative body gastritis, or of the rare ulcerative antrum gastritis, have never been seen to develop into true gastric ulcers when observed over a long period of time.

When obstruction at the pylorus is present, a severe edematous gastritis, especially of the antrum, will be seen. It heals after gastroenterostomy. Although not checked statistically, I have the impression that generalized gastritis is not rare in duodenal ulcer. It may be due

to pyloric spasm which frequently accompanies duodenal ulcer, causing retention. This type of inflammation—inflammation by retention—evidently does not belong to the gastroscopic signs of the ulcer stomach.

2. *Duodenal Ulcer.*—Duodenal ulcers never can be seen with the gastroscope. In favorable cases, it is possible to see portions of the duodenum through the open pylorus, but so much shadow is cast that it is impossible to recognize details. The stomach of a patient suffering from duodenal ulcer, however, often presents the signs of an ulcer stomach, as described in the previous section (1).

The activity of the pylorus, when duodenal ulcer is present, usually is quite normal. The shortening of the antrum, the waves migrating over the antrum, the closing of the pylorus with a stellar form is as regular as in a healthy stomach. Even obstruction of the duodenum does not affect the regular normal action of the pylorus.

3. *Ulcer of the Pyloric Channel.*—Ulcer of the pyloric channel can never be seen gastroscopically. There is a decided difference, however, in the findings in cases with ulcers in this location and in those with duodenal ulceration. In cases with ulcers of the pyloric channel, usually the pylorus remains completely hidden from view, and not even that edge which is adjacent to the greater curvature can be seen. It is well known that the expert examiner is almost invariably able to see the pylorus through the flexible gastroscope with the patient lying on his left side. This is only possible because the pylorus is very mobile and in this position is adjacent to the anterior abdominal wall. If the pylorus is held by adhesions to the right side of the spine, then the spine is between the objective of the instrument and the pylorus, so that the latter remains hidden from view. It seems that in most cases with ulcer of the pyloric channel, adhesions are present, fixing the pylorus to the posterior wall of the abdominal cavity. This fact is especially important in cases with obstruction.

It frequently happens that in pyloric obstruction, which so often accompanies ulcer of the pyloric channel, the most refined x-ray relief compression technique is unable to differentiate between malignant and benign obstruction. With gastroscopy this seems to be easier. An obstructing tumor can always be brought into view through the gastroscope and can scarcely be mistaken for anything else. Perhaps the diffusely infiltrating tumors without any elevation and without any ulceration may occasionally cause difficulties. The pylorus obstructed by ulcer, on the other hand, almost never is seen through the gastroscope. Even if the antrum is observed over a long period of time, there are only slight peristaltic waves, and none of them brings the pylorus into view.

In the only patient with pyloric obstruction due to ulcer of the pyloric canal, in whom I could see the pylorus, it appeared as a pinhead-like, completely round hole in the background of the antrum. The

antral mucosa had the swollen appearance usual in obstructions. Operation and microscopic examination proved the correctness of the gastroscopic diagnosis.

4. *Prepyloric Ulcer.*—After 1,173 gastroscopies had been carried out with the flexible gastroscope, I saw my first true chronic prepyloric ulcer. This rarity of gastroscopically seen prepyloric ulcers may be due to three different reasons: (1) Probably prepyloric ulcers are not frequent. Holmes and Hompton[3] in their careful statistics have shown that the site of the great majority of all ulcers is the duodenum and the lesser curvature of the body, especially around the angulus. In their opinion, each prepyloric ulcer must be suspected to be malignant. Other authors (Sarah Jordan, W. L. Palmer) believe that benign prepyloric ulcer occurs, although rarely. (2) Also in prepyloric ulcer, just as in ulcer of the pyloric canal, the pylorus may be drawn backward by perigastritic adhesions, and thus remain hidden from view. (3) The lesser curvature of the antrum is the most important blind spot in gastroscopy. Frequently it can be observed only during peristalsis of the antrum (Borland), but in the majority of the cases, it remains hidden from view behind the angulus. Since the portion directly adjacent to the pylorus, however, is usually seen, this third reason seems the least important for the infrequent observation of prepyloric ulcers through the gastroscope.

5. *Gastric Ulcer.*—A few gastric ulcers are not seen when lying in so-called blind spots, otherwise the gastroscopic picture of gastric ulcer is of unexpected brilliance. There is a variety of nuances in color such as one never sees in the gross specimen. The observation of a chronic gastric ulcer, therefore, is most fascinating for the beginner in gastroscopy, as well as for the expert. In the gross specimen, the stream of circulation is interrupted. All of the gastric mucosa appears to be the same grayish pink. In gastroscopy, a multitude of colors are observed, ranging from brilliant white over grayish white, yellow white, yellow brown, pink, and red to the dark red of freshly oozing blood.

A. *The edge of the ulcer:* The edge of the ulcer invariably is absolutely sharp. It may be ragged or irregular, but the limit between the ulcerated surface and the surrounding mucous membrane always is seen distinctly. Whenever there is some blending of the ulcerated area with the surroundings, malignancy can be assumed with certainty. Sometimes there are small polypoid islands of still intact mucosa near the edge; they are also sharply defined. Frequently some portions of the edges are undermined for varying extents.

B. *The floor of the ulcer:* In the majority of cases, the floor of the gastric ulcer, as seen gastroscopically, has a definite brilliant yellowish color. This color is unexpected and most striking for the inexperienced examiner. Its origin has not been fully explained, but it may be assumed that the ulcerated surface is covered by a fibrinous layer. In

rare cases, the floor is brownish or dark red. While formerly this red ulcer was believed to be a healing stage, we now know that healing ulcers remain yellow until the last moment of epithelization. The red ulcer proves that a small hemorrhage has preceded the examination. These ulcers bleed easily, and sometimes a small river of blood can be seen oozing from the red ulcer to lower parts of the stomach. Gastroscopy cannot cause any bleeding. Sometimes the blood oozing from the center of the floor flows toward the lowest part of the crater, which is often not the center, and forms a brown pool there. The complete epithelization of the ulcer can be determined only by gastroscopy. The roentgenologic crater may disappear, but gastroscopy may reveal that the ulcer is present still, shallower, but not healed. Complete epithelization may require as long as two months after the complete disappearance of the niche, even when examined by the most refined x-ray compression,

Fig. 2.

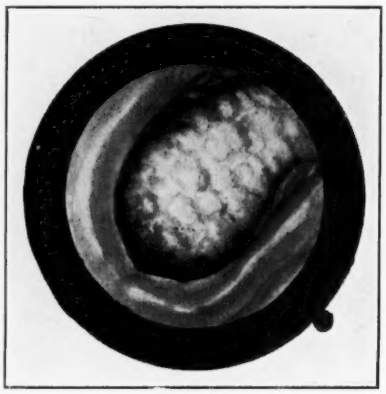

Fig. 3.

Fig. 2.—Penetrating ulcer. Large penetrating ulcer, lesser curvature. Sharp edge. Blood oozing from the center of the crater to its lowest portion. Tremendous inflammation of the adjacent posterior wall. At 5 o'clock the antrum is seen. Case checked by operation.

Fig. 3.—Gigantic penetrating ulcer. Posterior wall. Edge sharp. Floor formed by pancreatic lobuli. Benignity proved by course.

relief technique. This fact can become important in cases in which gastric surgery is considered.

C. *Penetration:* Chronic penetration of an ulcer is no contraindication to gastroscopy. It is not always possible to diagnose chronic penetration by the gastroscopic picture. In a case (Fig. 2) with a very deep craterlike benign ulcer, the floor was yellow and smooth, with some blood oozing from the center of the crater and with the surroundings badly inflamed. Operation demonstrated that the ulcer had penetrated the whole gastric wall and was covered by thickened layers of omentum. In contrast, the fact that an ulcer has penetrated into the pancreas may easily be detected with the gastroscope. The floor then is formed by the nodular-like lobuli of the pancreas which in the gastroscopic picture have a greenish gray color and which are uniform in size. This fact,

together with the sharp edge of the ulcer, prevents the examiner from wrongly diagnosing a carcinoma. (Fig. 3.)

It scarcely is necessary to emphasize that in cases of imminent free perforation of an ulcer with fever, local pain, and abdominal rigidity gastroscopy is contraindicated. Until now no perforation of an ulcer has followed the inflation of air through the gastroscope. In this respect, x-ray examination seems to be the more dangerous, since a number of perforations have been described following the palpation of the stomach during fluoroscopy of the stomach. Perforation of an ulcer following gastroscopy, however, would probably be much less dangerous than that following fluoroscopy; because in the former, the stomach would be entirely empty, whereas, in the latter, it would be filled with barium. The question might even arise whether conservative medical treatment in a case of ulcer perforation following gastroscopy would not be preferable to operation. I believe that operation would be safer and should

Fig. 4.—Perigastritis. White area in center is the ulcer. Three folds converge to its edge from 9 o'clock. At 2 o'clock the open pylorus. At 4 to 5 o'clock the musculus sphincter antri. Between ulcer and sphincter antri pouch due to perigastritic adhesions.

be performed immediately. In such a hypothetic case, it would be difficult to separate exactly coincidence and cause. Moutier described a case of a man who was scheduled for gastroscopy in the morning; during the preceding night he had a spontaneous perforation of the ulcer. Had this same perforation happened twelve hours later, gastroscopy would have been held responsible for the mishap.

D. *Perigastritic adhesions:* It has been pointed out that perigastritic adhesions are chiefly responsible for gastroscopic nonvisualization of pyloric ulcers and especially of benign pyloric obstructions. In gastric lesions, also, the gastroscopic diagnosis of adhesions sometimes becomes possible. The stomach may be distorted so much that the usual rules of orientation become useless. In a patient with a benign ulcer just above the angulus in whom six gastroscopies were done, we found in each examination a large outpouching in the anterior part of the angulus

(Fig. 4). This pouch was not like a spasm or like a diverticulum. It could be explained only by assuming tension perigastritic adhesions around the ulcer. Since no operation was performed, however, no proof was possible.

E. *Organic hourglass stomach:* The spastic narrowing of the stomach, often seen in x-ray examination, disappears in the gastroscopic examination. True organic hourglass stomach in which the tissues of the stomach are narrowed by scars seems to be rare. I saw only one case in the series used. I performed a gastroscopy on a colored woman in the gastrointestinal department of the General Hospital, Cincinnati, whose x-ray picture showed an hourglass formation. The gastroscope penetrated into the upper bag. There a diverticulum formation was seen. In its background was a small dark oval hole, the entrance into the lower bag. All parts of the mucosa were smooth. This patient, however, had a positive Wassermann reaction and had been treated for syphilis. I believe that many cases of organic hourglass stomach are due to gastric syphilis.

F. *Gross hemorrhage:* Gross hemorrhage is one of the most important indications for gastroscopy. Most hemorrhages nowadays are treated medically; in such a case, gastroscopy may be delayed until the danger is over. The postponement should not be too long, for it is well known that x-ray examination, if delayed a few weeks, frequently fails to reveal the source of the bleeding. The bleeding, however, may have a source which roentgenologically cannot be demonstrated. In addition to ulcer and carcinoma, tiny hemorrhagic erosions, small soft benign tumors, and small ulcerations in hypertrophic ulcerative gastritis may bleed; and such hemorrhages, especially in the latter disease, may lead to death. Therefore, as soon as possible, both x-ray examination and gastroscopy should be carried out. It is evident that a small but dangerously bleeding polyp must be removed surgically, while in cases of diffuse hypertrophic ulcerative gastritis, no surgery is indicated. In this connection, it may be mentioned that all workers who compared roentgenologic and gastroscopic findings agree that x-ray examination is not able to diagnose chronic gastritis, except some very rare cases of severe verrucose hypertrophic inflammation. This form was found only 3 times in 450 cases of chronic gastritis.

Gastroscopy becomes still more important if operation in the beginning of the gross hemorrhage is being considered. When a patient before bleeding has been known to have a definite x-ray niche then gastroscopy may seem to be superfluous. That is not so. A short time ago, I observed a patient with acute hemorrhage and marked duodenal fleck. Gastroscopy revealed that a small hemorrhagic erosion of the lesser curvature was profusely bleeding. The bleeding would not have been stopped by the resection of the ulcer. If the source is not known before, operation becomes more or less a gamble. It is well known how

often the surgeon opens the abdomen without being able to find the source of the bleeding. If, gastroscopically, bleeding from a gastric lesion has been excluded, hemorrhage from duodenal ulcer may be assumed and the patient operated upon. Gastroscopy is carried out so easily and quickly that it can be performed even in very weak patients. The washing out of the stomach with ice water has to be carried out on a table which permits Trendelenburg position. The stomach must be emptied speedily after quick good local anesthesia of the throat, or even, if necessary, under general anesthesia. An expert can perform the gastroscopy in one minute. Then the surgeon may go ahead with the operation or abandon it, according to the gastroscopic findings.

Fig. 5.—Chronic hypertrophic ulcerative gastritis. Two gastric folds. In the left one, an ulceration surrounded by a red area. In the valleys between the folds, nodular excrescences.

GASTROSCOPIC DIFFERENTIAL DIAGNOSIS OF THE VARIOUS TYPES OF GASTRIC ULCERATIONS

It cannot be the aim of this paper to give a description of the gastroscopic aspect of the various gastric diseases leading to ulceration. The differential diagnostic criteria, therefore, shall be mentioned only briefly.

1. *Hemorrhagic Erosions.*—They have been described above. They always are seen in a noninflamed normal mucosal area. They are gray, shallow; the border is hemorrhagic. Frequently multiple mucosal hemorrhages and pigmented spots are found in the lesser curvature. Sometimes a real chronic ulcer is present in the same stomach or in the duodenum of the same case.

2. *Erosions of Chronic Superficial Gastritis.*—These are small, often only pinheadlike. They sometimes can be diagnosed only because a high light sliding over the erosion vanishes for a moment during the respiration. Sometimes they have a small, red border. The surroundings are superficially inflamed, presenting adherent layers of mucus, red patches, and edema. These erosions heal quickly.

3. *Erosions of Chronic Atrophic Gastritis.*—Such erosions are rare. They are seen in a thin greenish gray mucosa, are gray of color, and disappear in a few days.

4. *Ulcerations of Chronic Hypertrophic Gastritis.*—Usually this differential diagnosis is easy, but in some cases it may be very difficult, and a final decision may be reached only by repeated examination. These ulcerations are yellow and are not so shallow as those of the other types of gastritis. They are multiple, lying in velvety, swollen, often nodular and irregular mucous membranes (Fig. 5). They are much more frequent in the body of the stomach than in the antrum, where they are found only exceptionally. If patients suffering from this severe disease have frequent gastroscopic examinations, it will be observed that the ulcerations heal rapidly (within three to four days), but that ulcerations in another location appear. I never have observed this ulcerative form of chronic hypertrophic gastritis in connection with chronic gastric ulcer. Great diagnostic difficulties may arise when a single ulceration is seen in a markedly hypertrophic, inflamed area. Fortunately, these cases are very rare. In two such cases observed over a long period of time, I first saw an area of hypertrophic gastritis. Later an ulceration in this area was seen which did not develop into chronic gastric ulcer but which disappeared completely after a few days. Under my observation, I have never seen a true gastric ulcer develop from hypertrophic gastritis. If the described doubtful picture has been found, the patient should have another gastroscopy one week later. If the ulcer then has completely disappeared, the diagnosis of chronic hypertrophic gastritis can safely be made.

5. *Syphilitic Ulcerations.*—I have not seen untreated syphilis of the stomach and have observed but two treated cases showing scar formation. Since the end of the war, syphilis has been eliminated by adequate propaganda and treatment so thoroughly in Germany that in the past ten years it has been almost impossible to show a primary chancre as well as the tertiary lesions to students of medicine. Therefore, I have to refer to Moutier's description. He saw a large elliptical ulcer in a tumor-like swollen surrounding. The floor of the ulcer was quite yellow, baconlike. The picture in Moutier's textbook represents a typical gumma which when seen in this form could not be mistaken for any other kind of ulceration. I had the occasion to observe one case (by courtesy of Leon Schiff, General Hospital, Cincinnati) which had been treated only for a short period. Stiff nodular infiltration of the posterior wall was seen. Differentiation from infiltrating carcinoma without ulceration would have been impossible without the knowledge of the serologic findings. Schiff told me that previously through the gastroscope he had seen superficial ulcerations which had disappeared following antisyphilitic treatment.

6. *Tuberculous Ulcerations.*—It is well known that gastric tuberculosis is so rare that it has to be considered as almost a curiosity. No gastroscopic reports exist. However, at autopsy, tuberculous tumors of the pylorus and multiple small tuberculous ulcers, usually in the greater curvature of the antrum, have been observed. It should be possible to diagnose these forms correctly, because tubercles, small gray nodules, will be seen at the edge of either lesion. Whether the tumoral form can be differentiated from carcinoma, syphilis, etc., is of no importance in this discussion. It seems unlikely that one would mistake small tuberculous ulcerations for true gastric ulcer, although perhaps their differentiation from gastritic ulcerations might not be easy.

7. *Carcinomatous Ulcer.*—The differentiation between benign and malignant gastric ulcer, especially in small lesions of the lesser curvature, is of the greatest importance for the surgeon. In this differentiation, gastroscopy is superior to the inspection of the gross specimen and is

Fig. 6.—Carcinomatous ulcer. The ulcer is seen at 9 o'clock. Its left border is sharp, but the right one blends with the surroundings. At the right side of the field irregular nodes. At that time clinically still benign ulcer was assumed. Resection two months later proved correctness of gastroscopic diagnosis.

equaled only by the microscopic examination. This statement puzzles the physician who is not the gastroscopist and especially the surgeon and pathologist. Repeatedly the expert gastroscopist makes the diagnosis of a very small ulcerlike carcinoma; the surgeon excises it, inspects it, and considers it benign. The pathologist, well experienced in this condition, makes no macroscopic diagnosis; the microscopic section then proves the correctness of the gastroscopic diagnosis. This superiority of gastroscopy is effected by the presence of circulating blood during the examination. The circulating blood renders the picture plastic and brings out the various colors. The essential gastroscopic difference, as stated before, between a benign and a malignant ulcer is that the edge of the benign ulcer is entirely sharp; whereas, the malignant ulcer at least partly blends with the surroundings (Fig. 6). The color of the floor may be whitish in both the benign and the malignant ulcers; on the other hand, it is sometimes, though rarely, dirty

gray or brownish even in benign ulcers; but the gradual passing to the surrounding orange red color proves malignancy with certainty. Another important sign of malignancy is the irregularity of the floor. The nodules formed by the lobuli of the pancreas described above must not be mistaken for malignant nodules; more characteristic are ridgelike excrescences never occurring in benign ulcers. I observed one case in which an ulcer roentgenologically appeared probably to be benign and which gastroscopically even had a sharp edge; but from its floor projected a narrow gray ridge; therefore, carcinoma was diagnosed, and the diagnosis was proved to be correct after resection and microscopic examination. Stiffness of the mucosa surrounding an ulcer also is a sign of malignancy, but its recognition is very difficult even to the expert. Sometimes it is so marked that it cannot be mistaken for the more soft hypertrophic gastritic changes around a benign ulcer. Formation of nodes around the ulcer is a very characteristic sign of malignancy. These nodes are big and irregular and can easily be differentiated from the equal small nodules of hypertrophic gastritis.

The gastroscopic picture of the great majority of ulcerated carcinomas is very characteristic. The floor is dirty brown, or violet, or gray of color, often covered by necrotic pieces. The edge is irregularly ragged, blending with the surroundings. A wall surrounds the ulcer which often has an irregular nodular appearance; its color usually is dark red, in contrast to the pale pinkish anemic mucosa. In other cases, the dark red ulcer is surrounded by brilliant white necrotic mucosa.

Ulcerations seen in high elevated papillomatous or polypoid tumors or in lymphoblastoma cannot be mistaken for benign ulcer.

FINDINGS IN THE STOMACH AFTER OPERATION ON GASTRODUODENAL ULCER

Although gastroenterostomy and gastric resection in gastroduodenal ulcer result in different physiologic conditions, the same gastroscopic findings have been observed in both types of postoperative stomach; therefore, a separate description is superfluous.

The gastroenterostomy stoma usually is well seen gastroscopically. In rare cases, it remains hidden from view in a blind spot on the posterior wall. Stomas of resection are easily seen. In an astonishingly great number of cases of resected stomachs, the flexible Wolf-Schindler gastroscope enters the intestine. Its interior can then be well observed. It is characterized by the circular parallel jejunal plicae and the Kerkring folds. These are also sometimes seen through the stoma of a gastroenterostomy with the gastroscope still entirely in the stomach. The color of the intestine is a little bit browner than that of the stomach. The edge of the stoma rarely is smooth and round. Often an elevated wall is seen containing nodules and even polyplike formations. These, however, are pseudopolyps, for after repeatedly comparing operative procedures and subsequent gastroscopic pictures, one gets the convic-

tion that all nodes, elevations, crests, and pouches seen around stomas in postoperative stomachs are artefacts caused by the operation. Every invagination, every prominent suture line the surgeon carries out remains unaltered through the lifetime of the patient.

The stomachs of patients who regain health after operation for gastric ulcer are peculiar as far as the stoma is concerned. I described, in 1923, that in such cases the stoma of a gastroenterostomy has a pylorus-like, rhythmical action. It opens and closes with stellar formation in a distinct rhythm. This rhythm is different from that of the pylorus, a fact demonstrable when pylorus and gastroenterostomy are observed in the same visual field (Fig. 7). Although this type of stoma does not protect against recurrent ulcer, it does protect almost invariably against gastritis of the postoperative stomach. It seems that gastroenterostomies of the distal part of the stomach are more apt to develop the rhythmical function than those of the upper two-thirds. Direction

Fig. 7.—Gastroenterostomy with normal rhythm. The cavity seen is the antrum, bounded by the "angulus." In the background the open pylorus. At 2 o'clock the gastroenterostomy closing with a stellar formation.

and size of the incision may also play a rôle. This is still a wide field for surgical research. In the last few years, I have observed stomas of resected stomachs that also have shown the same rhythmical action.

Four anatomic diseases of the stomach operated on for ulcer may be observed: (1) recurrent, marginal, and jejunal ulcers; (2) chronic gastritis and jejunitis; (3) silk sutures hanging into the cavity of the stoma; and (4) obstruction of the stoma. A fifth disease, carcinoma of the stoma, apparently does not occur after gastric operations for chronic ulcer, and, therefore, a discussion of it will be omitted in this chapter.

1. *Recurrent, Marginal, and Jejunal Ulcer.*—Recurrent ulcer of the postoperative stomach does not differ gastroscopically from the original ulcer. In one instance, there were six definite, though shallow, ulcers seen in the lesser curvature.

The marginal ulcer gives an unmistakable picture. It is always almost completely white. Gastroscopically its diagnosis is easier than in

the gross specimen, because of the brilliant colors while the blood still is circulating. In one instance, a marginal ulcer was suspected by x-ray examination. Gastroscopically it was easy to find this crater, but three additional ulcers were seen. This proves that small ulcers of the stoma are better seen by gastroscopy than by x-ray.

The jejunal ulcer offers greater difficulties. Sometimes its location may be so low down in the jejunum that it cannot be seen, but in other cases it is easy to observe the interior of the jejunum, and then the diagnosis can be made without difficulty. In a case of resection, I followed such a jejunal ulcer by thirteen gastroscopies (Fig. 8). With medical treatment, it finally healed completely.

2. *Chronic Gastritis and Jejunitis.*—All gastroscopists agree that chronic gastritis is by far the most frequent disease of the postoperative stomach. All kinds of changes are seen: superficial edema, patchy reddening, purulent secretion, hypertrophic swelling, inflammatory

Fig. 8.—Jejunal ulcer. The edge of the stoma (case of resection) and the jejunal plicae are well seen. Purulent secretion, the right edge of the ulcer.

erosions, and even atrophic areas. All observers agree that this complicated type of chronic gastritis is the worst one and cannot be cured unless it is possible to undo the gastroenterostomy. In such a case, I saw rapid healing of the inflamed mucosa.

Since rhythmical action of the artificial stoma protects against this gastritis, it must be assumed that the uncontrolled reflux of intestinal juice constitutes the decisive etiologic factor. It cannot be decided whether the chemical or the bacteriologic qualities of the intestinal juice are of greater importance.

Henning found that chronic jejunitis frequently is combined with chronic gastritis. Reddening and purulent secretion of the jejunum occur, but they are rare. Chronic inflammation of the stomach usually ends exactly at the margin of the stoma. In a single case which was examined gastroscopically four times, we saw the rare picture of ulcerative jejunitis. The patient had undergone a resection because of duodenal ulcer. He developed gastric pain. The gastroscope easily en-

tered the jejunum to a depth of ten centimeters. There the mucosa was entirely normal. In withdrawing the instrument, the second loop of the coil was observed, and peristaltic waves of the jejunum were seen. The mucosa at this point was normal. By withdrawing the instrument still further, the jejunum close to the stoma was observed. The proximal three jejunal plicae and the edge of the stoma presented a great number of small, dirty, grayish ulcerations. The ridges of these plicae looked moth-eaten. The gastric mucosa of this patient presented all signs of severe hypertrophic gastritis but without any ulcerations. Treatment, continued over months, diminished the subjective complaints of the patient considerably, but the objective findings remained unaltered. It should be emphasized that this picture was found only once in 117 cases of postoperative stomachs.

Fig. 9.—Gastroenterostomy. Marginal ulcer. Silk suture. The black hole is the gastroenterostomy, evacuating intestinal juice into the stomach. Above, the white large ulcer and the black silk suture.

3. *Silk Sutures.*—Surrounding an artificial stoma, silk sutures are often found, covered by transparent mucosa. They are seen as black hook-shaped lines and are innocent foreign bodies not causing any subjective symptoms. Occasionally one of these sutures cuts through the mucosa and then is seen as black thread, hanging freely into the lumen. The parts of the suture emerging from the mucosa are yellowish. This type of foreign body is not innocuous. The silk suture, by means of the rhythmical peristalsis of the stomach, is rubbed along the mucosa; an area of very marked, usually erosive, superficial gastritis can be seen. In one instance, I saw such a long suture at the posterior margin of a gastroenterostomy, while a large marginal ulcer had developed at the anterior margin (Fig. 9). It was impossible to prove whether the silk suture had caused the ulcer. Both ulcer and silk suture were found in the resected specimen. Microscopically typical foreign body giant cells were present. Probably all cases in which silk sutures hang free in the gastric cavity need reoperation.

4. *Obstruction of the Stoma.*—Modern surgical technique makes the artificial stoma large enough to avoid obstruction. I never have seen a case with stoma too narrow for the regular passage of food. Gastroscopy at times permits unusual diagnoses. In a patient suffering from recurrent epigastric pains after gastroenterostomy, I saw the stoma easily; it was contracting rhythmically, pushing with each contraction brilliant white material into the stomach. This observation was not an entirely new one for me. In 1922, I had observed the same phenomenon, but then the ejected material had been dirty, gray, irregular necrotic particles, a picture which immediately permitted the diagnosis of a necrotic tumor below the gastroenterostomy, which was confirmed by subsequent operation. In the quoted case, however, the material ejected from the intestine into the stomach was not necrotic tissue, but of brilliant white color resembling the barium often found in the stomach if gastroscopy is carried out too soon after x-ray examination. The patient was questioned and said that three days before (!) he had taken bismuth powder. The unusual diagnosis of obstruction of the intestine beyond the gastroenterostomy was made and was proved correct by operation (S. Strauss). The pathologist (Saphir) found that immediately below the gastroenterostomy the loop of the intestine was pulled upward and fixed on the gastric wall by adhesions. There a large pouch formation of the intestine was found. Evidently the intestine was obstructed by the adhesions; the bismuth powder had remained in the pouch and had been pushed back into the stomach by rhythmical contractions.

BRIEF COMPARISON BETWEEN GASTROSCOPY, GASTROPHOTOGRAPHY, AND ROENTGENOLOGIC EXAMINATION

Gastrophotography has been done with the gastrophotor, a small camera which, after introduction into the stomach, permits the exposure of eight films. The results, even with improved optical system, are not satisfactory for two reasons: (1) it is impossible to know which area of the complicated gastric surface is seen on the developed and magnified film; (2) the most sensitive films do not satisfactorily differentiate yellow and red colors so important in gastroscopy, especially in the diagnosis of ulcer. This latter disadvantage is best shown by making photographs through a rigid gastroscope. The brilliant yellow surface of a gastric ulcer appears on the film exactly as gray as the surrounding orange red mucosa does. The presence of the ulcer can only be judged by the shadow cast by an overhanging undermined edge. Therefore, gastrophotography is considered valueless.

Roentgenologic examination is, on the whole, of greater value than gastroscopy in gastroduodenal ulcer, in contrast to carcinoma and chronic gastritis. Ulcers of the duodenum and of the pyloric canal cannot be seen by gastroscopy but are easily demonstrated by x-ray examination if modern relief compression technique with localized exposures is used.

Gastric ulcers are sometimes missed by roentgenoscopy, found by gastroscopy, and vice versa. The final healing stage of ulcer can be determined only by the gastroscope; this is true also as regards the detection of accompanying inflammation and of the differential diagnosis from carcinomatous ulcer.

COMMENT; VALUE OF GASTROSCOPY IN GASTRODUODENAL ULCER FOR THE SURGEON

1. Gastroscopy reveals gastric ulcers not demonstrable with other methods.

2. The success of medical treatment, complete epithelization, can be determined only by gastroscopy.

3. Gastroscopy usually permits the differentiation between benign and malignant ulcer of the lesser curvature.

4. Early diagnosis of very small carcinomatous ulcers and their successful surgical treatment would more often become possible if each patient, in whom a crater of the lesser curvature had been found roentgenologically, were over thirty-five years of age.

5. The extent of inflammation accompanying gastroduodenal ulcer can be determined only gastroscopically. This may be of decisive influence upon the indication for operation. Probably the surgeon would not operate on an inflamed area because he would be afraid of the gastritis that might develop later in the postoperative stomach.

6. The source of gross hemorrhage may be determined gastroscopically. The respective findings either facilitate surgery or prevent it.

7. Recurrent marginal or jejunal ulcers of the postoperative stomach often can best be seen by gastroscopy. If after repeated gastroscopies they have been shown to be refractive to medical treatment, surgical treatment may be considered.

8. Gastroscopy permits the physician to observe whether or not an artificial stoma is working in the normal rhythmical way.

9. Gastroscopy alone permits the diagnosis of the most common disease of the postoperative stomach, chronic gastritis, and jejunitis.

10. Gastroscopy reveals the presence of free silk sutures in the postoperative stomach. These constitute a definite indication for reoperation. Also, rarer complications in the postoperative stomach, such as obstruction of the intestine by adhesions, occasionally may be diagnosed gastroscopically.

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THE INDICATIONS FOR OPERATION IN CASES OF UNCOMPLICATED PEPTIC ULCER*

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IN THIS symposium our part concerns itself with the indications for operation in the case of uncomplicated peptic ulcer—that is to say, ulcer without pyloric obstruction, perforation, or notable bleeding. It is a difficult question, and in the individual instance important arguments both pro and con can usually be assembled; hence there can never be any dogmatic answer or simple formula of procedure.

The ground can perhaps best be cleared by presenting briefly our own philosophy of the symptoms of peptic ulcer, already exposed in other articles.[1, 2] First of all it must be emphasized that the exact mechanism of the production of discomfort in people with ulcer is not at all clear. Two main views are held. The first and the most widely advocated maintains that the open ulcer, irritated by acid, is the direct cause of pain, just as a sore on one's hand is painful. The second regards the ulcer as one incident in a syndrome featured by indigestion and (as a rule) a profuse secretion of highly acid gastric juice; the symptoms are thought to be due, not to acid irritation of the ulcer, but to spasm, or at least an abnormal state of tension of the gastroduodenal muscle. It is this latter view which we believe to be correct for the following reasons:

1. Ulcer may develop to the point of perforation with no symptoms of any sort.
2. So-called "ulcer symptoms"—indigestion—may continue after the ulcer is healed.
3. Symptoms may continue after the ulcer is excised.
4. "Ulcer symptoms" may exist in a patient in whom no ulcer has ever been demonstrated.
5. Nonulcerative lesions, such as a polyp, may be associated with so-called "ulcer symptoms."
6. "Ulcer symptoms" can best be reproduced in man by mechanical procedures, such as inflation of the duodenum by balloons.
7. Relief of "ulcer symptoms" by soda can be achieved by doses of alkali too small to neutralize the gastric contents.
8. Relief of symptoms can at times be produced by nonalkaline substances.

All this, we believe, supports the view that the "indigestion" of patients with noncomplicated ulcer is due to abnormal states of spasm or

Received for publication, November 30, 1936.

tension of some part of the stomach or duodenum, and not as a rule to actual "soreness" of the ulcer. The ulcer, however, may act as a source of reflex irritation which may set up spasm and consequent indigestion; in this sense it is a more or less direct cause of symptoms. The argument briefly outlined above has been discussed at length elsewhere.[2]

It becomes clear then that there are two somewhat distinct problems in connection with the treatment of peptic ulcer, (1) the relief of symptoms and (2) the healing of the ulcer; these do not necessarily go hand in hand, and each has its separate surgical implications.

Indications for surgery from the standpoint of elimination of the ulcer.—As long as a peptic ulcer remains unhealed, it constitutes a hazard for the patient. One can never tell when perforation or serious bleeding will occur; one cannot be sure that scarring, adhesions, and obstruction will not develop. With unhealed ulcer of the *stomach*, there is the added risk, by no means insignificant, of the development of cancer. Theoretically, then, one might conclude that peptic ulcers should be promptly excised if at all resistant to medical measures, and, were the operation simple and safe and the results permanent, no one would dispute this position. But there are many well-known difficulties and disadvantages. Even in the best hands there is a sizeable mortality from gastric operations; with the ulcer safely out other symptoms may supervene; and recurrences after operation are of course frequent. This last and very serious difficulty is evidently due to the fact that some people tend to form ulcers repeatedly and the excision of any single lesion fails to reach the root of the trouble. It is clear then that no formula of procedure can be derived and the decision to advise operation will always include many intangibles, such as the patient's reaction to illness, his economic status, his age, the availability of supreme surgical talent, and many others.

Indications for surgery from the standpoint of relieving symptoms.—The tendency in recent years has been to veto the idea of operation in cases of peptic ulcer unless perforation, obstruction, serious bleeding, or other complication has supervened. The point at issue is whether surgical interference is ever indicated purely for the relief of "indigestion" in patients with simple peptic ulcer. We believe that it often is indicated for the following reasons: If the immediate cause of symptoms is an abnormal state of spasm or tension of gastroduodenal muscle, and if over a reasonable period of time diet and other medical measures have failed to give relief, then one may be entirely justified in attempting to break up these abnormal states of motility by means of operation. The difficulty is to know just what to do, and the very multiplicity of procedures which have been advocated shows that surgeons have discovered no really rational basis for their manipulations. Whether they cut or suture here or there, relief is obtained in a certain proportion

of cases, whereas in others, things are no better or even worse. It seems reasonable that operations planned primarily to relieve symptoms of indigestion should include not only an excision of the ulcer, since it may be the trigger zone for indigestion reflexes, but also a plastic procedure which yields a wide outlet in the pyloric region. From a physiologic standpoint, this would seem to offer the best chance of averting "ulcer indigestion," although the degree of benefit to be achieved in the individual case can never be correctly predicted.

In conclusion, we feel strongly that both surgeons and internists have been thinking in narrow terms with too much emphasis on the ulcer itself; symptoms too often are blamed directly on it, therapy centers wholly on its healing or elimination; and not enough stress is laid on the fact that tendency to ulcer formation, indigestion, and a high gastric acidity are as a rule the common *results* of some underlying diathesis or disorder. Elimination of the ulcer alone may no more cure the entire disease than treatment of nephritic retinitis will cure the sick kidney; they are both the effects of a common cause.

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ACUTE MASSIVE HEMORRHAGE FROM THE UPPER GASTRO-INTESTINAL TRACT

With Special Reference to Peptic Ulcer

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THE rapid loss of a large quantity of blood from any source is always alarming. Few conditions with which the physician has to deal create more uncertainty than the patient who, with little or no warning, feels faint and then vomits a basin full of blood. Such individuals may have little or no nausea but a desire to defecate and find that a large liquid stool is black or even bright red. Frequently fainting actually takes place and the family may discover the unconscious victim on the bathroom floor.

When the physician arrives, he finds the patient in some degree of shock. There is obvious pallor, sweating, restlessness, and a rapid pulse. Usually these individuals are recognized as potential casualties and are referred to the nearest hospital for treatment. Immediately the question arises concerning the source of the hemorrhage. One must bear in mind that even with the ulcerated vessel on the duodenal side of the pylorus most of the blood may be vomited. Thus in a previous study[1] of 371 bleeding duodenal ulcers occurring in a ten-year period at the Massachusetts General Hospital, we found 22.6 per cent had hematemesis only, 38.3 per cent had melena only, and 39.1 per cent had both hematemesis and melena. One naturally thinks of the most frequent source of such massive hemorrhage from the upper gastrointestinal tract, i.e., duodenal ulcer. There are, however, several other lesions of this region that bleed profusely and that produce the same acute picture. These are gastric ulcer, gastric carcinoma, gastrojejunal ulcer, esophageal varices, leiomyosarcoma, and hypertrophic gastritis. A brief discussion of these lesions over the same ten-year period, 1923 to 1932, occurring in the Massachusetts General Hospital will be set forth. However, special reference to the management of peptic ulcer associated with massive bleeding will be our chief consideration.

During the decade from which this study was made, there were 72,447 admissions to the wards of the Massachusetts General Hospital. Two hundred and thirty-one or 1 out of every 313 patients, were brought in for acute massive bleeding from the upper gastrointestinal tract. These are represented as follows:

Received for publication, April 8, 1937.

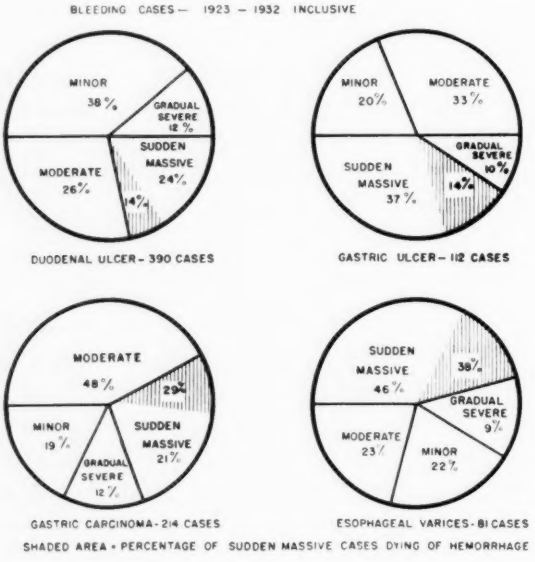
Duodenal ulcer	94	Esophageal varices	37
Gastric carcinoma	45	Gastrojejunal ulcer	8
Gastric ulcer	42	Leiomyosarcoma	3
	Hypertrophic gastritis	2	

The incidence of massive hemorrhage in all these lesions admitted during the same period are represented in Table I. Fifty-one of the to-

TABLE I

SUDDEN MASSIVE HEMORRHAGE—1923 TO 1932 INCLUSIVE

	TOTAL CASES	SUDDEN MASSIVE CASES	DEATH FROM HEMORRHAGE
Duodenal ulcer	1002	94	13
Gastric ulcer	434	42	6
Gastric carcinoma	615	45	13
Gastrojejunal ulcer	35	8	2
Esophageal varices	219	37	14
Leiomyosarcoma	4	3	1
Gastritis	23	2	2



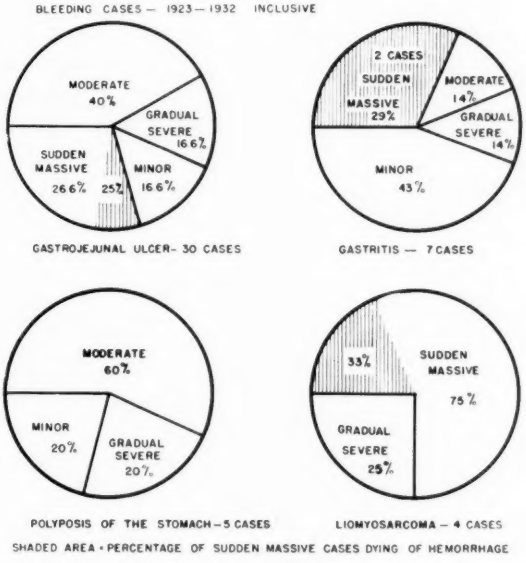
Graph I

tal acute hemorrhage cases, or 22 per cent, died of hemorrhage while in the hospital. The various factors contributing to the differential diagnosis and the treatment of those from peptic ulcer will be considered.

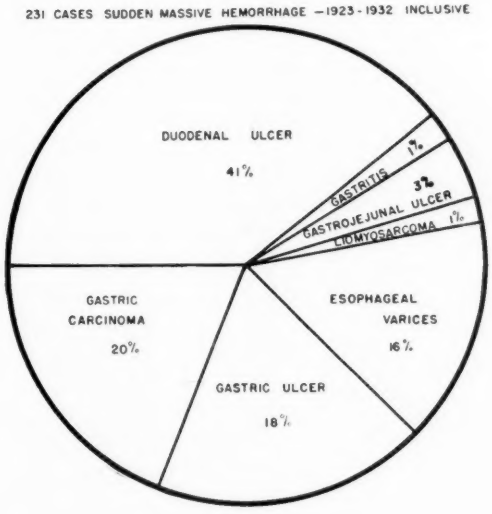
DUODENAL ULCER

This diagnosis was made, 1,002 times on ward patients during the interval under discussion. Of these, 390 had gross bleeding detectable while under observation. Ninety-four bled profusely and actively in sufficient quantities to produce shock and acute anemia. In addition, 48 more bled sufficiently to finally attain the minimum level, or below

it, to be classed as severe bleeders, although slowly enough to create no emergency. All of the cases in the acute massive group and in the gradual severe group were found to have red blood counts below three million and hemoglobin below 70 per cent. Thirteen of these patients bled to death.



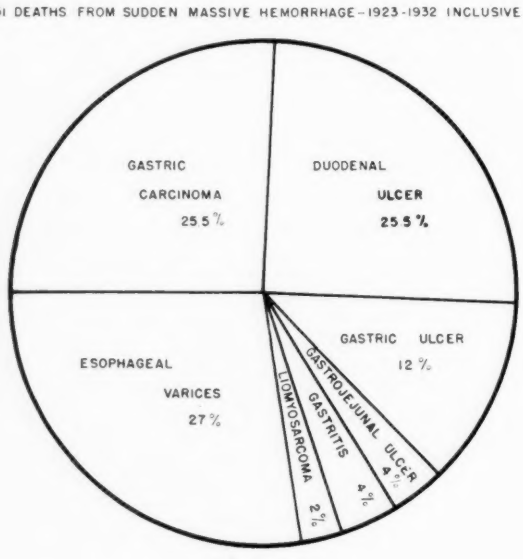
Graph II



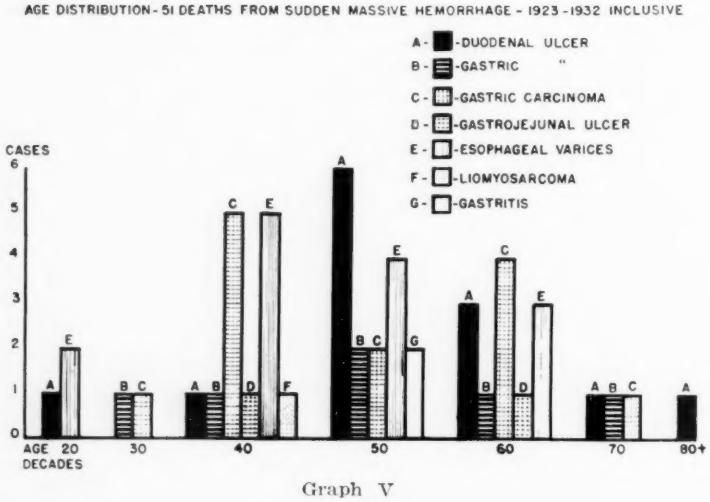
Graph III

In a previous communication, Allen and Benedict[2] analyzed all of the common factors in a similar series of cases over a twenty-year period in an effort to find what could be determined regarding the cause of continued bleeding and death in these patients. It has been frequently

stated that, although such individuals may almost bleed to death, they rarely do. Our analysis showed that the age of the patient had more bearing on the question of spontaneous cessation of hemorrhage than any other factor. In 90 patients who bled acutely and massively before the age of fifty years, only 4 died. In 42 patients who were over fifty years of age, 14, or exactly one-third, died of hemorrhage. Al-



Graph IV


AGE DISTRIBUTION - 51 DEATHS FROM SUDDEN MASSIVE HEMORRHAGE - 1923-1932 INCLUSIVE
A - DUODENAL ULCER
B - GASTRIC "
C - GASTRIC CARCINOMA
D - GASTROJEJUNAL ULCER
E - ESOPHAGEAL VARICES
F - LIOMYOSARCOMA
G - GASTRITIS
CASES
AGE 20 30 40 50 60 70 80+
DECADES

Graph V

though it is well known that women are less likely to have duodenal ulcer than men in a ratio of about 1 to 4, those women who do have duodenal ulcer are just as prone to bleed profusely, but in our small series they were much more likely to have a spontaneous remission than men of the same age. Chronicity of the ulcer, habits, occupation, pre-

vious bleeding, etc., seemed to play no rôle in the question of recovery. Nine out of 20 fatal cases died from their first period of massive hemorrhage. Also, it was found that if operation was delayed for a week or more in a patient continuing to bleed either constantly or with repeated episodes every day or two, no patient was saved by surgery regardless of what was done.

Faced with these facts, we must consider what can be offered these patients; first, in the acute phase; second, in the quiescent state. In the early hours of acute massive hemorrhage from duodenal ulcer, we may well say that if the patient is under fifty years of age and has elastic vessels, conservative measures are indicated, because it is unlikely that we can hope to operate upon them and ligate their bleeding vessels

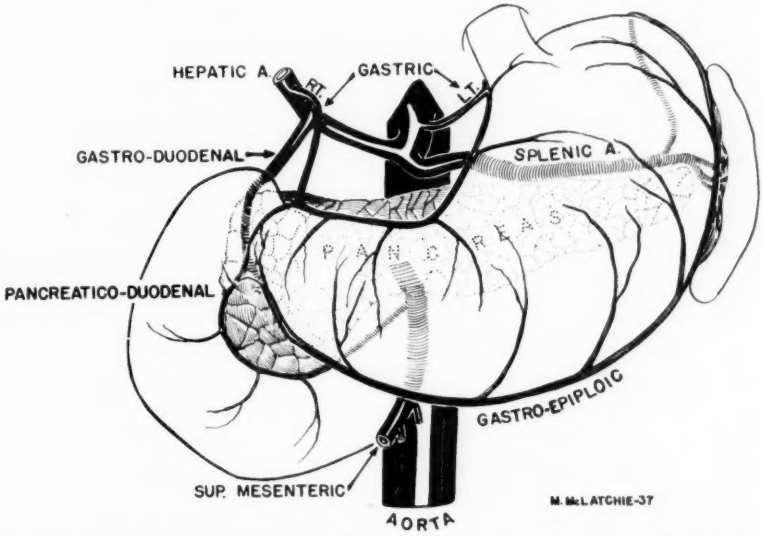


Fig. 1.—Schematic drawing indicating the course of the gastroduodenal artery behind the first portion of the duodenum. Note the direct communications between this vessel and the gastroepiploic and the pancreaticoduodenal arteries, all three vessels arising from different sources.

with a mortality of less than 5 per cent. In the older age group, however, we can justly use Finsterer's[3, 4] much quoted forty-eight-hour time limit to advantage. Certainly in the good risks we should be able to definitely improve a mortality rate of 33½ per cent which occurred in those treated conservatively.

When one considers the type of ulcer that produces this picture and its relation to the blood vessels in this region, it is easy to understand that as these vessels become eroded, the inelasticity of the vessel wall in later life will materially influence effective clot formation. The deep penetration of the posterior wall ulcer into pancreatic tissue, at a point where the gastroduodenal artery transverses it, increases not only the risk of continued bleeding but makes any operative procedure one of

major consideration. As shown in Fig. 1, we see that this vessel anastomoses in such a way as to make it necessary to ligate it between its three different sources and the ulcer area. One can hardly expect to open

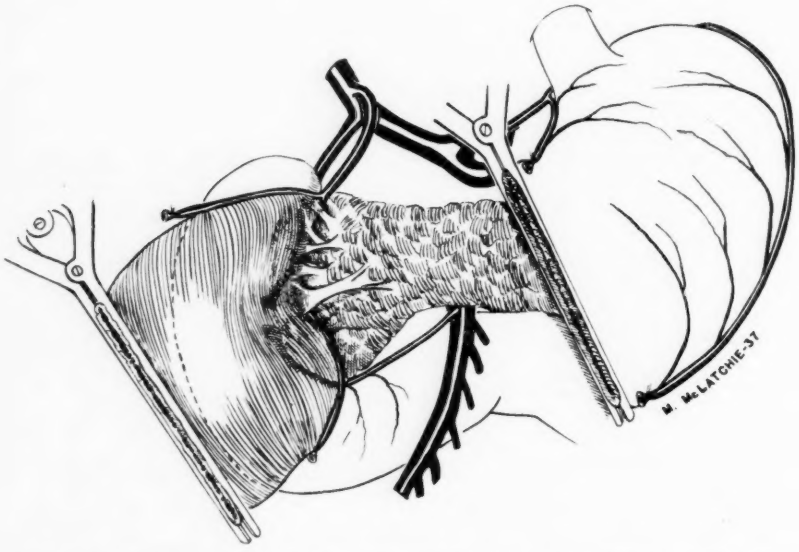


Fig. 2.—Schematic drawing illustrating the method of approach to the bleeding area in the posterior wall duodenal ulcer with erosion into the pancreas. The stomach has been transected and the distal portion elevated.

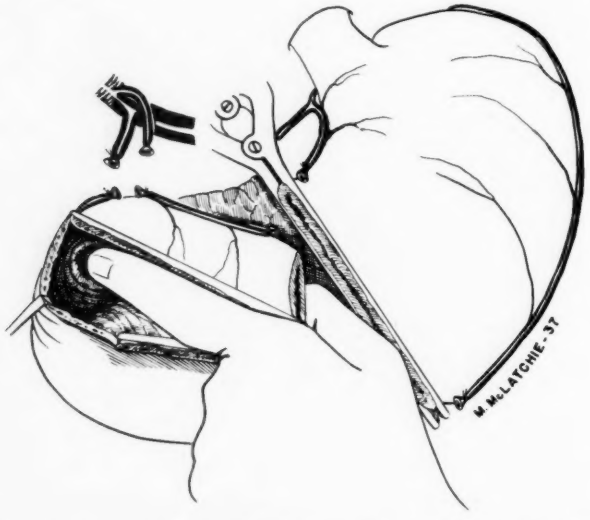


Fig. 3.—Schematic drawing illustrating control of the bleeding vessel by compression with the index finger of the left hand. The distal segment of the stomach has been widely opened down the anterior surface through the pylorus. Note the opportunity of visualizing the papilla of Vater.

the anterior wall of the duodenum and successfully place ligatures in this friable ulcer bed, nor can one safely pass stitch ligatures in such a way as to occlude the vessels in healthy tissue from within. This method

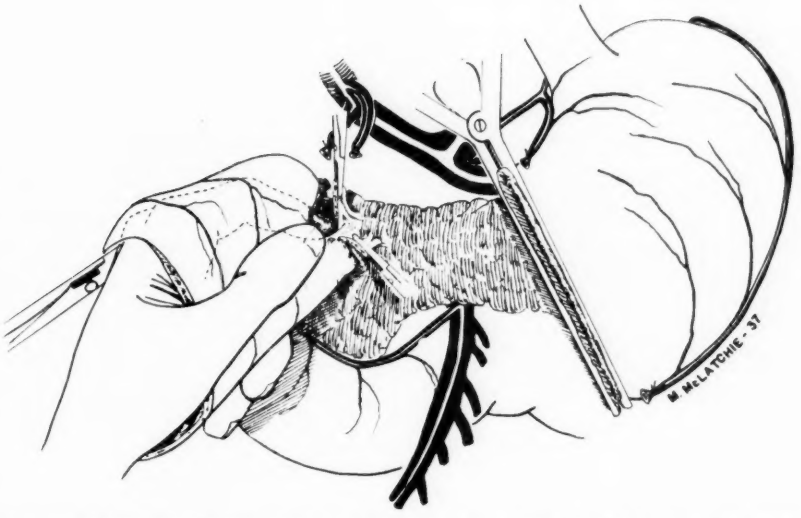


Fig. 4.—Schematic representation of ligating all vessels leading into the inflamed area. The ulcer has entirely eroded through the duodenal wall, into pancreatic tissue. It is broken into from behind and no attempt is made to remove or cauterize the ulcerated portion of the pancreas.

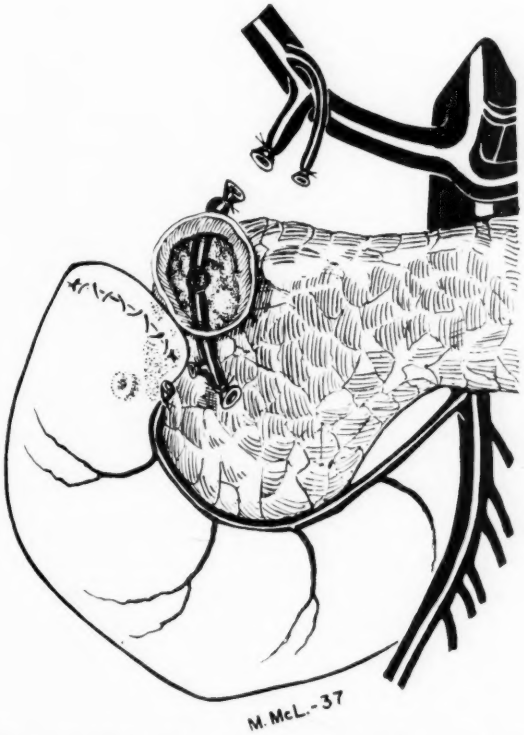


Fig. 5.—Schematic drawing of the ulcer and eroded vessel with the duodenum freed on the distal margin and turned in well above the papilla of Vater. The eroded pancreas can be covered with a tab of omentum. Stab wound drainage to the subhepatic space of Morrison can be instituted if one fears leakage from an injured or eroded accessory pancreatic duct.

has succeeded in isolated instances but more often has met with failure either from loss of blood on the table or from further necrosis and secondary bleeding.

Finsterer[3-5] advocates direct tamponade in some extensive ulcerations into the pancreas with a secondary resection after the patient has recovered from the effects of blood loss. When he can, with reasonable safety, complete his operative procedure in one stage, even in acute bleeding, he does so; and one would judge from his writings that he is carrying out radical procedures in the majority of such cases. In a

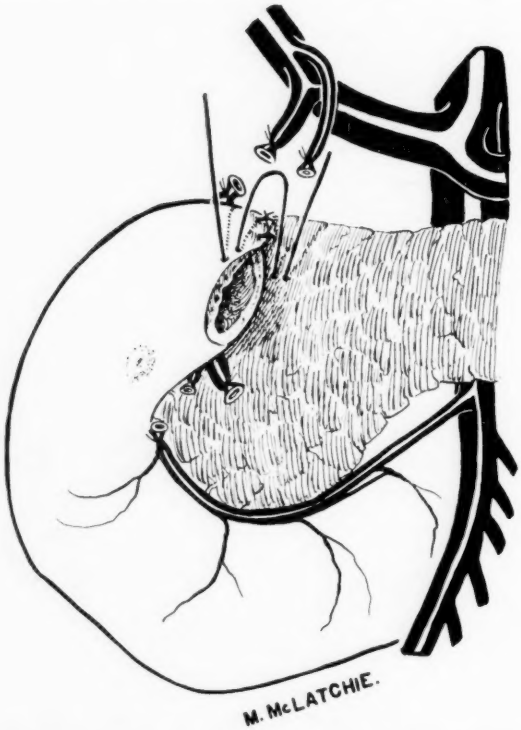


Fig. 6.—If the ulceration is low on the duodenum, and the location of the papilla of Vater is such that closure of the duodenum cannot be safely accomplished as illustrated in Fig. 5, one can leave the posterior margin of the duodenum attached and suture the anterior edge to the pancreatic capsule. It is important to approximate the serous coat of the duodenum to the pancreas. This can be reinforced by omentum. This method has the advantage of allowing any pancreatic secretion that may exude from the ulcer bed to drain into the duodenum.

large group of actively bleeding ulcer patients, he has successfully ligated the bleeding vessels and resected the distal two-thirds of the stomach with a very low mortality, 5 per cent, or less, if the operation was undertaken within forty-eight hours of the onset of hemorrhage. He has not refused to operate on those patients who have been referred to him late; i.e., after a week or more of continued or repeated bursts of profuse bleeding. In this late group, his mortality has been 30 per cent. He apparently feels that by excluding the extensive, deeply penetrating ulcer on the posterior wall of the duodenum, by transection of the

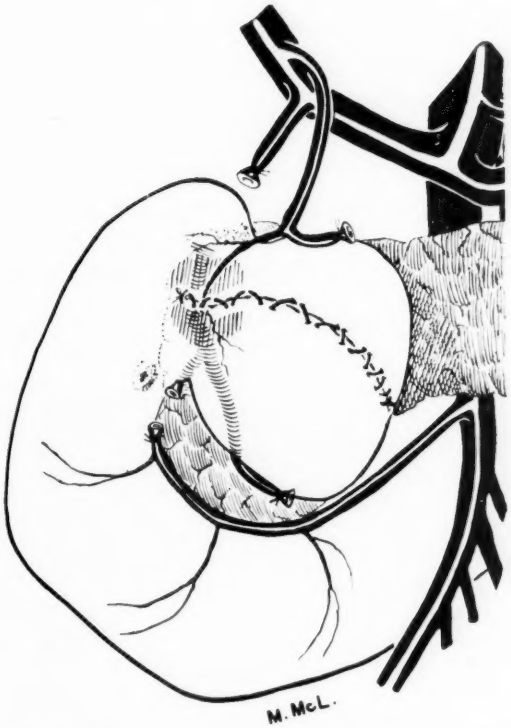


Fig. 7.—Schematic representation of a method of closing a small portion of the distal segment of the stomach over the ulcer bed after the vessels have been ligated under vision. One may facilitate the closure of this region by removing the mucous membrane as suggested by Bancroft.[19]

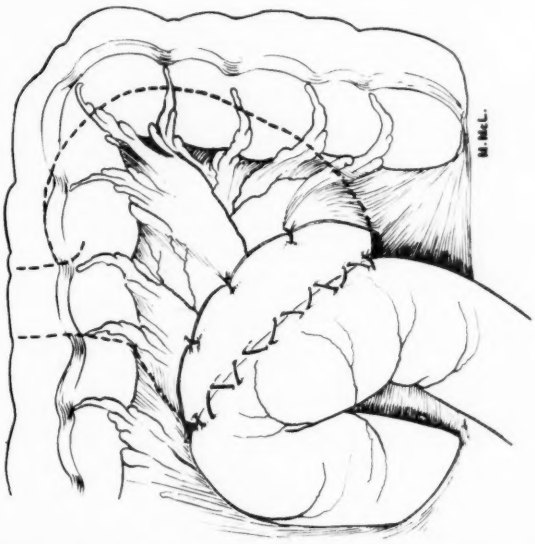


Fig. 8.—The high posterior Polya anastomosis should be made with a short loop, the proximal jejunum placed to the lesser curvature. It should be arranged to enhance direct drainage from the stomach into the distal limb of the jejunum.

duodenum proximal to the ulcer, or by transection of the antrum two fingerbreadths from the pylorus, and then removing the distal two-thirds of the remaining stomach, his end-results are nearly, if not entirely, as good as when the actual ulcer area in the duodenum is included in the resection. He calls this operation "resection for exclusion." We are of the opinion that in doing this operation the radicals leading into the ulcer bed are ligated.

Many surgeons have had the experience of failure in gastroenterostomy for massive hemorrhage in duodenal ulcer. These patients continue to bleed and finally succumb to anemia because the eroded vessel leading into the ulcer bed is still open. In those instances where bleeding has

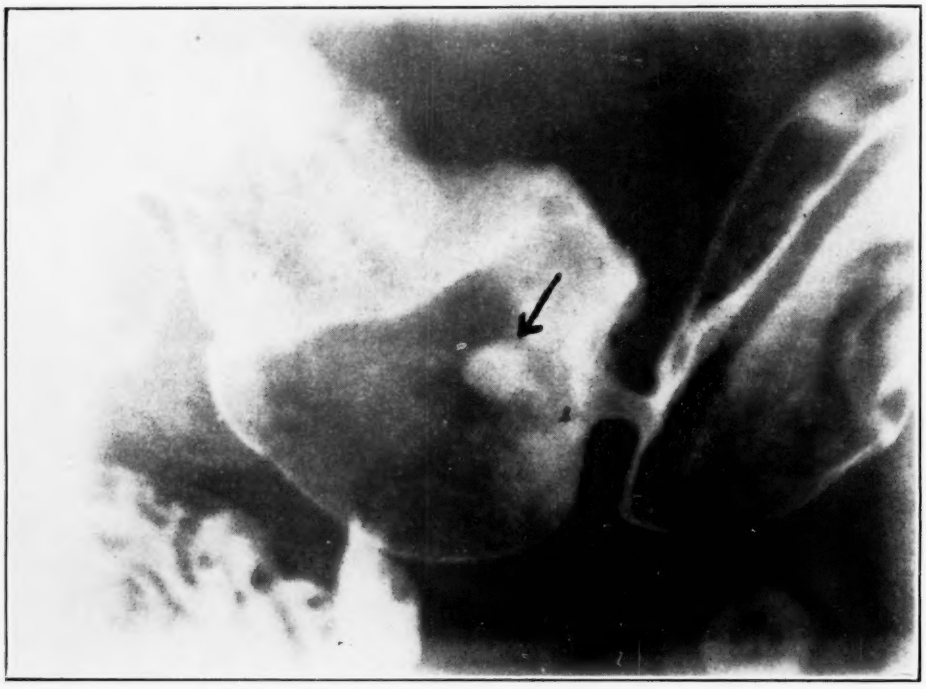


Fig. 9.—Ulcer on the posterior wall of the duodenum. Patient is supine with right side up. Thick barium coats the stomach, pyloric valve, and duodenum and the gas bubble in the stomach fills the antrum, pyloric valve, and duodenum, thus allowing double contrast examination.

stopped and the patients have recovered for the time being following gastroenterostomy, we believe that usually the bleeding would have subsided spontaneously on conservative treatment. We have offered[2] a method of control of the bleeding vessel by direct exposure while the dissection and ligation of the main arteries leading into the area is carried out (Figs. 2 through 8). This is a logical procedure and if practiced early in the episode of acute hemorrhage, i.e., as soon as the patient has recovered from the initial shock, will be met with success. The occasion for its use arises infrequently but if considered carefully with known duodenal ulcer, bleeding acutely, if such a patient falls into

the group beyond the age of fifty years, where death from hemorrhage occurs once in three such cases, a certain number of these patients can be rescued. Trout[6] approves of this procedure, and Ochsner,[7] Sowles,[8] and others besides myself have successfully carried out this operation.

In the quiescent or interval stage of posterior wall duodenal ulcer, particularly after one or more episodes of massive bleeding, one is confronted with the problem of proper treatment. If the patient is young and responds well to a dietary regime, we may justly feel that radical surgery is meddlesome. This is particularly true if by Hampton's[9] technique of following these patients by x-ray examination, we find that the crater actually fills in and in so doing nature has not caused an obstruction to gastric contents that must pass this region. Certainly some of these patients manage to get along comfortably and safely for many years. On the other hand, it is well known that this type of ulcer, particularly if it has eroded a large vessel, is unusually resistant to medical measures.[10] Not only are such patients prone to have continued or frequently repeated episodes of discomfort, but they also have recurrences of massive bleeding. This occurs even under conditions that appear to be ideal. We believe that radical surgery offers these individuals a more comfortable life and at the same time eliminates the possibility of a fatal hemorrhage from an eroded vessel later, at a time when there may be sufficient sclerosis in the vessel wall to prevent a spontaneous cessation of bleeding. Prior to 1932 we transected the antrum, turned in the ends, and did a posterior gastroenterostomy in fifteen such patients after the method of Devine. The results were disappointing in that many of the patients continued to have periods of activity in their ulcers, as evidenced from their symptoms, and had recurring bouts of bleeding. Since then, we have resected the distal one-third to two-thirds of the stomach and when possible the ulcer-bearing portion of the duodenum in thirty-eight consecutive posterior wall duodenal ulcers that had bled. All of these patients recovered from the operation and remained well for varying periods of time. Some of them have developed new ulcers, either at the stoma of the posterior Polya anastomosis or on the remaining portion of the lesser curvature of the stomach. In each instance that this new ulcer has developed, it has caused episodes of bleeding. None of these patients, however, have so far died of hemorrhage. Thus we have probably protected most of them from fatal hemorrhage by ligating the large vessels overlying the head of the pancreas, but we have failed to alter not only their ulcer diathesis but their hemorrhagic tendency as well. We are now trying a more radical resection of the stomach hoping that we may, by following more closely the technique of Finsterer, come nearer to his 90 per cent of symptom-free patients. Certainly we must eliminate, if possible, not only the likelihood of fatal hemorrhage in such cases, but while so doing, get a high percentage of permanently relieved patients and a low operative mortality. This must be considered

a surgical lesion although radical or even crude, if you choose, until such time as medicine has mastered the whole question of peptic ulcer. Our experience so far would indicate that the more radical the resection, the less likely a poor end-result. Certainly gastroenterostomy in this group as a whole is unsatisfactory. In the elderly patient with cicatricial obstruction, this conservative procedure is most successful. In the more continuously active ulcer lesions of the posterior wall, penetrating or bleeding cases, we feel that anything short of a two-thirds gastrectomy will give a high percentage of failure. One cannot compare this group with all duodenal ulcers. Doubtless the high ratio of cures twenty years ago following gastroenterostomy was due to the physiologic changes brought about by this operation, the majority of which today are cured by medical measures. Such a large proportion of all ulcer cases are successfully treated conservatively now that when surgery is resorted to for persistent symptoms or massive hemorrhage, we are faced with an entirely different problem. These recalcitrant cases require more than the physiologic changes brought about by pyloroplasty or gastroenterostomy.

GASTRIC ULCER

In spite of the fact that a larger percentage of gastric ulcerations are associated with massive hemorrhage, we find coincidentally that the percentage of deaths from hemorrhage is exactly the same as in duodenal ulcer (Table I). The average age of these fatal cases is slightly lower than in duodenal ulcer, but still there is not the marked difference in the age of the patient that we expected to find. One has the advantage then of classifying acute massive bleeding from pepic ulcer on the same basis, whether it be gastric or duodenal, as far as treatment is concerned. The type of operation may be varied in the two lesions and one has a better chance for a two-stage operation in the gastric lesion. The ulcer should be widely exposed and the vessels leading into the eroded one must be ligated in healthy tissue outside the stomach wall. This is usually best accomplished by a free incision into the normal anterior wall of the stomach so that the bleeding vessel can be visualized and compressed during the process of ligating the anastomosing branches. With this accomplished, one can close the opening in the anterior wall and allow the patient to recover from this experience. An operation of election for relief of the persistent ulcer, if such exists, can be carried out to better advantage four to six weeks later. If possible to avoid gastroenterostomy at the time of the emergency procedure, the secondary operation is less restricted as to choice. One may be able to free the ulcer and resect it entirely at the first operation. This is an excellent method and sometimes the most feasible one to insure ligation of the vessels involved in the hemorrhage. This is likely to be the case if the ulcer has penetrated the pancreas. When it can be done or must be done as the procedure of choice, then a superimposed gastroenterostomy may

prove sufficient to eliminate a secondary operation of election. One cannot help feeling less radical about extensive resections in bleeding gastric ulcer, since gastrojejunal ulcer is so much less prone to follow posterior gastroenterostomy in this group than in those done for relief of duodenal ulcerations. Benedict[11] found no instance of stomal ulcer in posterior gastroenterostomy done for gastric ulcer in our hospital.

GASTROJEJUNAL ULCER

When acute massive hemorrhage is associated with a stomal ulcer, we must be prepared to consider the possibility of a fatal outcome. The inflammatory process may involve and erode a large vessel such as the gastroepiploic or the colic arch. This offers a very difficult operative procedure because it is usually necessary to take down the old anastomosis in order to find the bleeding vessel. We believe, however, if this is attempted in the early days of bleeding that success will follow in more than 75 per cent of such procedures; since in our 8 cases, 2 succumbed to hemorrhage on a conservative regime. One is again reminded of the care that should be used in placing the opening in the mesentery of the transverse colon through which the anastomosis between the jejunum and the stomach is made, as far away from the main vessels as possible. This point is usually stressed on the basis of keeping the anastomosis as far away from the colon as possible so that a jejunal ulcer may be less likely to become further complicated by a gastrojejunocolic fistula.[12] It is now generally conceded that gastrojejunal ulceration is unlikely to respond to conservative measures, and certainly there can be little argument against surgery if such lesions have produced active massive bleeding.

CARCINOMA OF THE STOMACH

With the comparative frequency of massive hemorrhage in gastric carcinoma, it may seem odd that no such case has been subjected to emergency surgery under the impression that we were dealing with benign ulceration. As a matter of fact, the diagnosis is frequently obvious or so strongly suspected that this error has not been made. These patients are nearly always cachectic; there has usually been a very short period of gastric disturbance; weight loss has been striking; and often a mass is felt. Distant metastases, particularly in the pelvis, are common. When acute massive hemorrhage occurs in such patients, one has little initiative for carrying out anything but palliative measures. If the patient recovers from the bleeding, then the question of resection must be considered. Peritoneoscopy has been found of great value in determining the operability in gastric cancer. The 20 per cent of five-year cures in this disease (Parsons[13]) makes it worth while to continue radical surgery in any case without liver involvement or distant metastases. In eleven consecutive total gastrectomies for adenocarcinoma in

our hospital, six have survived the operation. One is apparently free of recurrence three and one-half years after operation. We should be constantly on the lookout for the linitis plastica type as here one could have every hope of a cure.

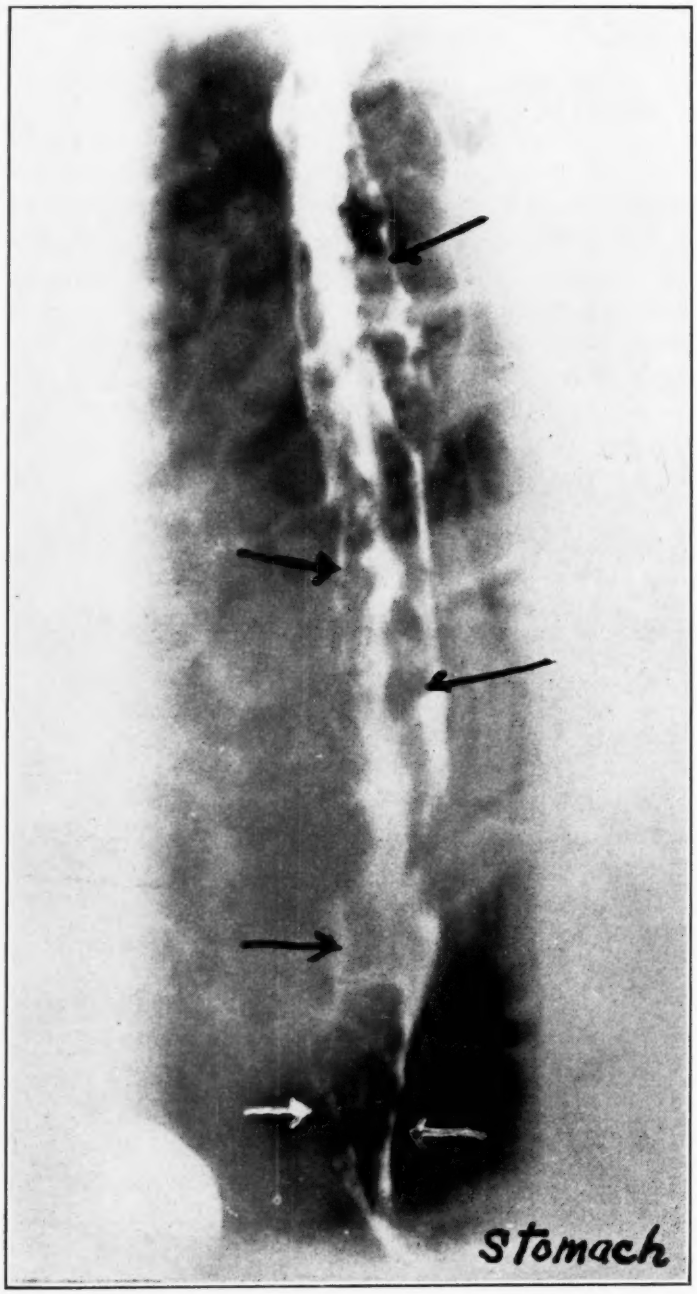


Fig. 10.—Typical picture of varices in the esophagus. Left anterior oblique view: respiration suspended at quiet breathing after the ingestion of thick barium mixture.

ESOPHAGEAL VARICES

Death from acute massive hemorrhage in varices of the esophagus may occur in a patient with no previous hospital record. In the majority of such cases, however, there are neither previous studies that have pointed to cirrhosis of the liver or thrombosis of the splenic vein. When the diagnosis is in doubt and the evidence points to a remediable hemorrhage from peptic ulcer, one is justified in carrying out x-ray examination of the esophagus by Schatzki's[14, 20] method, even in the presence of brisk bleeding. It is interesting to note that since this method of examination has come into practice in our hospital we find the diagnosis of cirrhosis of the liver and esophageal varices made twice as often as it was in the ten-year period immediately prior to 1932.

LEIOMYOSARCOMA

A very small series in this group, but the tendency for massive hemorrhage is striking. The prognosis with operation is so good that should the diagnosis be made, we should consider surgery in the early hours of bleeding. These lesions have a characteristic x-ray appearance. A large sessile tumor that is smooth in outline with a small deep crater is found. This leads to the serosa, and the bleeding comes from an erosion of a good-sized vessel on the outer surface of the stomach, often on the lesser curvature.

HYPERTROPHIC GASTRITIS

It seems difficult on first impression to account for fatal hemorrhage from gastritis alone, but in two instances in this series, no large open vessel could be found at postmortem. There was in one of these fatal cases a very large area involving approximately two-thirds of the mucosa and that had been almost entirely cast off, forming what resembled a huge, very shallow ulceration. This patient had consumed large quantities of some strong alcoholic beverage shortly before entry. She vomited an enormous amount of blood and died within forty-eight hours of acute anemia. One may feel that this was in the nature of a chemical erosion, and perhaps it should be so considered. The other death seemed to be based on a true hypertrophic gastritis with enormously enlarged rugae, and at autopsy there was no single large eroded vessel. The massive hemorrhage had apparently taken place from the engorged mucosa extending over practically the whole interior of the stomach.

During the past four years, since a better x-ray technique for gastritis has been developed and with the advent of gastroscopy[15] as a frequent means of study, the diagnosis of hypertrophic gastritis has been made ten times as frequently in our hospital as it was in the ten-year period covered in this study.

POLYPOSIS

Bleeding must occur to some extent at some time or other in nearly all of these cases, although only five of the cases in this group showed gross bleeding while under observation. It was somewhat of a surprise that none of them in this decade had sudden massive hemorrhage and none died of acute anemia. When one sees the size of the blood vessel in the stalk of some of these polyps, it is not hard to visualize that erosion with massive and even fatal hemorrhage is a possibility. One such patient died in our hospital in 1933.[21]

COMMENTS

Details as to the conservative management of acute massive bleeding have not been considered a part of this discussion. We feel, however, that some questionable points along this line may be briefly discussed to advantage.

Blood transfusion has been criticized as a method of treatment in the early stages on the basis of interfering with nature's efforts to bring about clot formation in the open vessel. We have all seen patients bleed again after a transfusion and frequently have felt that by hastening the elevation of blood pressure and increasing the volume of blood we may have brought about a fresh burst of bleeding. On the other hand, we have seen patients die from the lack of a transfusion and in no instance have we seen transfusion responsible for fatal hemorrhage. We do feel that continuous drip transfusion as advocated by Marriott and Kerwick[16] can be carried too far. It is easy to tell when this blood is lost as rapidly as it is put in, and under such circumstances, it should not be relied upon as a method of cure. Gordon-Taylor,[17] one of the early advocates of this method, has now changed his ideas concerning its efficacy. He now believes that Finsterer's principles are the most logical and practices the forty-eight-hour rule in any case that continues to bleed. All of us are in accord with the importance of blood replacement. We should have a considerable amount of compatible blood on hand if operation in the acute stage is to be undertaken. We feel that donors should be lined up and 500 c.c. of citrated blood kept in the refrigerator for instant use in every case of acute massive hemorrhage. We further believe that this should be withheld in the early stages of hemorrhage until the systolic blood pressure has fallen to 70 mm. One should not delay beyond this point, however, and citrated blood given slowly at this time will not elevate the blood pressure rapidly or restore the blood volume so abruptly as to blow out any clot that may be forming at the site of the open vessel. If such a patient under observation spontaneously ceases to bleed, then even after several days, the prepared blood can be given to hasten the normal restoration of blood elements.

Sedation of a patient actively bleeding has been a questionable point. Bulmer[18] believes that too much morphia may be the cause of a higher

mortality, in recent years, in this group of patients. He admits that better transportation facilities may play a rôle in that more such patients are delivered alive to the hospital. Finsterer[5] warns against too much morphia in these depleted patients prior to operation. We should consider this phase of the problem carefully, as we are aware that the restless stage of shock may be harmful, and doubtless there is a proper middle course.

We are inclined to feel that an inlying Levine tube may be worthy of consideration in massive bleeding from the stomach or duodenum. The situation is not exactly similar to the elimination of clots in the urinary bladder, but more or less the same principle is involved. At any rate, this tube allows the aspiration of gastric and salivary secretion which may hinder clot formation. Also, it offers an opportunity to identify fresh episodes of bleeding prior to the point of nausea and vomiting or fall in blood pressure. Without doubt it minimizes the peristaltic activity in this region by keeping the stomach empty. Also, it eliminates vomiting which in itself may dislodge a life-saving thrombus in the open vessel.

In the active stage, fluids should be given by hypodermoclysis rather than intravenously or by proctoclysis. The latter method increases peristalsis which in itself mitigates against physiologic rest. Lavages of ice water and adrenalin are of little value, and both would appear to interfere with nature's efforts. The whole basis of treatment should be rest, quiet, and comfort. Under these circumstances, a spontaneous cessation may be expected in the majority of cases.

Anesthesia.—Much has been said about local anesthesia and splanchnic block as a method of choice if operation is undertaken during acute bleeding. This would seem to work more satisfactorily in the hands of some surgeons than others. If the operation is done within the first forty-eight hours, the patient should have no more likelihood of respiratory complications than a carefully prepared patient for gastrectomy in the elective stage. We believe that an unsuccessful local anesthetic, accompanied by nausea or a restless patient during the operation, will do more harm than an expertly given inhalation anesthetic. We prefer a combination of novocaine block and gas-oxygen-ether, both being started in the operating room at approximately the same time. If the inhalation gases are given in a closed type of machine, excellent control can be maintained and the patient always lightly anesthetized. Whether novocaine only, general anesthesia alone, or a combination of the two are used, it is important to eliminate vomiting during the operation. A properly functioning Levine tube to which suction is applied aids greatly in this respect. We believe that basal anesthetics in their usual doses are very dangerous in these depleted patients and for this reason should not be used at all, since it is so difficult to properly gauge the

dose under these circumstances. Careful administration of small doses of morphia one-eighth to one-quarter of a grain is safe and helpful.

The operation if undertaken in the acute stage must be carefully planned. It is a poor one to attempt in the middle of the night with an inadequate staff. After all, one has a reasonable amount of time for preparation if the surgeon and internist are willing to work together on these problems. Plenty of compatible blood should be available and the definite steps of the whole procedure thought out beforehand. If this is done, the mortality should be low, even though the operation is of a radical nature. If we should elect to subject all patients with acute massive hemorrhage from peptic ulcer, regardless of age, to operation in the early days of bleeding, we could indeed expect a low mortality. Taking only such cases beyond the age of fifty years, we still feel that these individuals should be carefully considered on the basis of comparative mortality with early surgery properly carried out, versus expectant treatment.

SUMMARY AND CONCLUSIONS

1. The relative frequency and causes of cases of acute massive hematemesis admitted to a large general hospital in an urban community have been considered.

2. Death from acute bleeding in the upper gastrointestinal tract occurred in 51 out of 231 such cases.

3. Peptic ulcer accounted for 67 per cent of these massive hemorrhages and 41 per cent of the deaths.

4. The age of the patient with peptic ulcer is the most important factor in the prognosis. Duodenal ulcer rarely causes fatal bleeding under the age of fifty years, while beyond this age the mortality is 33.33 per cent.

5. Operation is urged in the better risk patients in the older age group in the acute stage of bleeding. Delay should not be extended beyond forty-eight hours. The bleeding vessels should be ligated.

6. Peptic ulcer associated with massive hematemesis should be considered a surgical lesion as an elective procedure, regardless of the age of the patient, in those who have spontaneously recovered from an episode of bleeding.

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PEPTIC ULCER: ITS SURGICAL TREATMENT BY CONSERVATIVE MEASURES

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THE ideal of surgical treatment of any chronic nonmalignant disease is to bring about relief of symptoms and prevent recurrence of the disease, and to achieve these aims by the simplest and safest possible method. The trend of surgery will always be toward such a standard of perfection, and although this trend in respect to simplicity and safety of operation may be carried to such an extreme as to lead to ineffective treatment, persistence in such efforts in many fields of surgery has profoundly changed, and at times even eliminated, formerly accepted methods of treatment. This trend has been evident in the management of varicose veins, prostatic obstruction, inguinal hernia, and cancer of the uterine cervix, and it has contributed much toward the satisfactory management of such conditions by the use of methods and principles which are more simple, even though they may require measured judgment and even more exacting technical skill in their execution than the more radical procedures. In peptic ulcer, attempts to control the disease by conservative measures have had a thorough trial, and an appraisal of the value of these methods is always necessary in any consideration of the treatment of this disease.

The general principles of the treatment of peptic ulcer have changed considerably within a relatively short period. It has become increasingly apparent that the medical management of peptic ulcer is on a more satisfactory basis than ever before and that, as a result of this, relatively fewer patients with the disease require surgical treatment. This improvement in medical treatment has evolved to a large extent from a wider recognition of the fact that satisfactory healing of the lesion is most likely to be effected when a patient thoroughly understands the circumstances under which symptoms are likely to manifest themselves, and adjusts his habits of living so as to eliminate those more common factors which he has found have to do with initiating or aggravating the symptoms. In addition, there is now a better understanding of the administration of alkalies and of the use of buffer substances and those preparations which inhibit gastric secretion. The suggestion recently made that a deficiency of vitamin C may be a factor in preventing healing of the lesion and, particularly, may at

Received for publication, August 30, 1937.

least be a contributing cause to gastroduodenal hemorrhage either with or without ulcer promises to add to the efficiency of medical treatment.

The first step, then, in the treatment of peptic ulcer is the establishment of a conservative regimen based on those general and specific measures which have proved to be valuable; such management maintained over a sufficient length of time will then control the disease and its symptoms in a large percentage of cases. In those cases in which such measures adequately carried out fail to accomplish this control and symptoms persist to a degree to justify surgery, the principles of surgical management require as careful consideration as do those of medical management.

The so-called conservative operations which are employed in the treatment of peptic ulcer may be divided into the indirect and the direct, in respect to whether or not the lesion is removed. The indirect operations, therefore, attain their purpose entirely by modifying gastroduodenal function enough to enable the ulcer to heal, remain healed, and also to prevent recurrence of the disease. It is true, therefore, that the value of the indirect operation is directly proportional to the permanency of its effect in controlling hyperactivity of gastric function, chiefly the secretory and motor mechanism. For this reason such procedures as interruption of the vagus nerve, which may have encouraging immediate effects, may ultimately fail to prevent reestablishment of hyperacidity and even introduce undesirable physiologic disturbances associated with new symptoms. Whether other procedures designed to deal with the acid factor, such as fundusectomy, advocated by Connell, can be developed to maintain a continuous control of the acid mechanism must be determined.

INDIRECT OPERATIONS

Jejunostomy.—Of the indirect operations, jejunostomy may be mentioned first because from a theoretical standpoint it is the ideal method of bringing about complete rest for the stomach and duodenum. From a practical standpoint, however, the operation is rarely indicated, principally because it does not modify gastric function, as any operation for ulcer must do, and whatever good effect the jejunostomy does have must terminate when the jejunostomy tube is removed; in other words, the maintenance of any treatment of a disease of such chronicity and tendency to recurrence must be possible.

Operations on the Pylorus.—The many procedures which have been devised to bring about ablation of the pyloric muscle have been based on the belief that pylorospasm is a factor in both the production and persistence of peptic ulcer and in the production also of the symptoms which are associated with it. Therefore, most of the operations on the pylorus have included either division or resection of the pyloric

muscle, which is designed to eliminate pylorospasm and by this means to prevent gastric stasis and to reduce activity. Usually an added purpose of these reconstruction operations on the outlet of the stomach has been to remove the lesion, but there has been convincing evidence to show, in the case of ulcers of the posterior wall of the duodenum for example, that such lesions heal without recurrence of ulceration following satisfactory reconstruction of the outlet of the stomach. This is particularly true when a small pyloric outlet resulting from hypertrophy or constriction of the muscle has been converted into a large outlet, the continuity of the muscle being permanently interrupted. There are, however, enough recurrences of symptoms and even of ulcer following any of the operations on the outlet of the stomach to make it obvious that this type of operation should be performed only under rather special circumstances. The chief indications exist when other, more effective conservative measures are contraindicated, particularly gastroenterostomy. These contraindications, in turn, are a high-lying stomach, or a previous operation making the performance of gastroenterostomy too difficult, or the presence of high acid values which have shown little modification under medical management. The most favorable group of cases for reconstruction of the pyloric outlet are those of young patients with marked pylorospasm in whom the inflammatory process is confined to the anterior wall of the duodenum.

There seems to be little difference in the results of the various pyloroplasties so long as the general plan originally developed by Finney is adhered to, namely, construction of a large pyloric outlet and permanent ablation of the pyloric muscle. In well-selected cases the results of pyloric reconstruction are apparently satisfactory in about 70 per cent. In those cases in which patients have not obtained what they consider a favorable result, the chief symptom of the majority is a sensation of epigastric distention; in the remainder, a recurrence of definite ulceration actually occurs. An important advantage of the operation, however, is that in the event of recurrent ulceration requiring further surgery the operation may be conducted as a primary procedure.

Gastroduodenostomy.—Gastroduodenostomy, as originally suggested by Jaboulay, is occasionally revived with some enthusiasm as a sound surgical treatment for duodenal ulcer. Again, from a theoretical standpoint, it is an operation which has much to commend it, since it is entirely indirect and therefore does not entail the risk which may be associated with removal of the lesion. Gastroduodenostomy can be accomplished with as much safety as any other procedure and provides for a large, added communication between stomach and duodenum. Nevertheless, the operation apparently has rare indications and its use is confined to those circumstances under which no other

procedure can be either easily or satisfactorily performed; under such circumstances it occasionally serves a very useful purpose. Its chief disadvantage, however, is that in cases in which it fails to bring about and maintain healing and control symptoms or in which a recurrence of ulceration takes place necessitating further operation, disconnection of the anastomosis, since it involves the second portion of the duodenum, is technically not easy to accomplish.

Gastroenterostomy.—Of the indirect, so-called conservative procedures, gastroenterostomy is the most useful, not only because of the great variety of circumstances under which it may be indicated and the excellent results which follow it in well-selected cases, but also because it is the only operation in which conditions prior to operation can be restored merely by disconnecting the anastomosis. The operation has its greatest application in cases of chronic duodenal ulcer in which there is impairment of motor function and in which the acid values are not unusually high. Since impaired motor function usually occurs late in the development of duodenal ulcer, it is in the most chronic cases that gastroenterostomy is so effective. If the operation could be confined to this group there would be little criticism of it, but the very fact that it did bring about such spectacular results in this group led to its employment in cases in which there was no impairment of motor function and in cases in which symptoms were of short duration. It is probably for this reason that so much criticism of the operation has arisen, because it is in this group that disappointing results are most likely to occur.

The emphasis which has been placed on these disappointing results and the occasional report of a case of jejunal ulcer developing many years after gastroenterostomy have obscured the real facts; namely, that when the indications for gastroenterostomy are understood and carefully observed, the results reported are strikingly similar. Between 80 and 90 per cent of patients have obtained satisfactory results following gastroenterostomy over a period of time much longer than has been reported for radical operations for peptic ulcer. The persistence of symptoms in about 10 to 15 per cent of the cases has been of sufficient degree, however, to justify calling the operation unsatisfactory, although it must be pointed out that these symptoms are less marked than they were before operation and are easier to control. In approximately 3 or 4 per cent of the cases, jejunal ulcers have developed subsequently. In reviewing the disappointing results, including the development of jejunal ulcer, we find that if surgery is required the situation is a fortunate one, because the gastroenterostomy can be readily disconnected, an advantage which is not held by other procedures.

While gastroenterostomy for gastric ulcer is theoretically not the ideal operation, it is a surprising fact that in those cases of gastric

ulcer in which, for some reason, removal of the lesion was not considered feasible and gastroenterostomy alone was done, the operation was followed by healing of the lesion in many cases in which other treatment had previously been of no avail. This fact is clear evidence of the marked influence of gastroenterostomy on healing benign ulcerations of the stomach and, taken in conjunction with the fact that it is almost a rule that if the anastomosis continues to function, any inflammatory process in the duodenum will heal and remain healed, is indicative of the use to which the operation can be put. Further, it has been shown that the prompt regression of gastritis which may be associated with peptic ulcer takes place under the influence of the operation. At the same time, however, one cannot propose gastroenterostomy as the ideal procedure for gastric ulcer because there is no way of absolutely determining at any time, except by microscopic examination, whether or not a gastric ulcer is malignant.

EXCISION

A direct operation for peptic ulcer, which might still be classified as a conservative surgical procedure, is excision of the lesion. In rare instances an ulcer may be so situated in the stomach (for example, on the posterior wall some distance from the lesser curvature or even approximating the greater curvature) that excision alone is justifiable. However, if deformity of the lesser curvature results from plastic closure of the defect after excision, this deformity may be responsible for the stasis and recurrence of symptoms and even ulceration which so often followed excision of gastric ulcer alone in the earlier days in the management of the disease. Excision alone, therefore, is rarely indicated for this reason, and also because nothing has been done to maintain any surgical management of the disease in respect to controlling hyperactive gastric function.

Excision of the lesion, therefore, is usually combined with one of the procedures already mentioned, according to the indications in the particular case. Most commonly this is gastroenterostomy, because it is the most effective of the conservative procedures in reducing acidity and in maintaining control of intragastric tension and hypermotility. Occasionally, excision of a gastric ulcer may be combined with reconstruction of the outlet of the stomach, providing the latter can be well accomplished as far as a large opening is concerned. Excision of a duodenal ulcer along with any of the foregoing procedures is theoretically advantageous in the case of the bleeding type of lesion, but results have shown that, in so far as gastroenterostomy is concerned, healing of any lesion in the duodenum may be anticipated; and if hemorrhage does take place after gastroenterostomy for hemorrhagic duodenal ulcer, it is more likely that the hemorrhage is due to causes

other than a recurrence or reactivation of duodenal ulcer unless the anastomosis has become obstructed.

COMMENT

As one reviews the many possibilities and combinations of these various conservative procedures and considers the great variability in peptic ulcer in its manifestations in different types of patients, the truth is apparent that the most successful surgical treatment which can be carried out for this disease requires a thorough familiarity with the basis on which patients are selected for operation and the selection of the procedure to be employed. The general principles which have been outlined have been proved over a long period of time to be so useful in the management of the disease, when surgery is clearly indicated, that any surgical method which involves considerably greater risk, unless it can promise absolute freedom from disappointing results (which no operation has, as yet, been able to do), should not be advocated as a routine procedure. The soundest argument for so-called conservative surgical treatment in peptic ulcer is that such methods when intelligently applied yield very satisfactory results, and these conservative measures will probably remain an important part of the surgical treatment of the disease as long as surgery of peptic ulcer is required.

PYLOROPLASTY AND GASTRODUODENOSTOMY

A Consideration of the Technique and Indications for These Types of Operation

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THE first operations to be attempted on the stomach, other than those for the repair of wounds of, or for the removal of foreign bodies from this viscus, were for the relief of obstruction at the pyloric outlet, usually due to a neoplasm. Possibly this statement is not entirely true, inasmuch as the first operations on human beings had been preceded by experimental resections on dogs, in which, of course, there was probably no actual disease. First to attempt such procedure was apparently John Jones, of Philadelphia, who conducted several such experiments in the latter half of the eighteenth century, but who left no present discoverable record of his pioneering work. He was followed about fifty years later by Merrem, of Giessen, who left an available, though not very detailed, report of stomach resections done on several dogs with discouraging results. Von Winiwarter and Gussenbauer, in 1876, following animal experimentation, were encouraged enough to propose the application of this operation of pylorectomy to human beings suffering with pyloric obstruction. This was attempted in 1879 by Péan and in the next year by Rydygier, both unsuccessfully. It remained then for Billroth, in 1881, to do the first successful resection of a tumor at the pylorus in a human being, and in so doing to give to surgery the operation which is yet known by his name, the Billroth I type of pylorectomy and anastomosis. To us, charged in this symposium with the discussion of pyloroplasties and gastroduodenostomies, all of this history is intensely interesting because every one of these early attempts was toward the reestablishment of the normal anatomic relationships, by anastomosing stump of stomach to stump of duodenum—a gastroduodenostomy. Although we do not intend or wish to enter in this article into any controversy on the relative merits of the various types of operations which have since been evolved, it should be said that we feel quite strongly that some form of anatomic restoration of relationships, where possible, is most desirable, and offers better functional results and prognosis than any of the methods involving an anatomic rearrangement. If it were not so, we probably would not have been chosen to write on this particular subject. It is our purpose to discuss and describe as impartially as possible the various operations which embody this principle, their advantages and disadvantages. To do this

Received for publication, March 11, 1937.

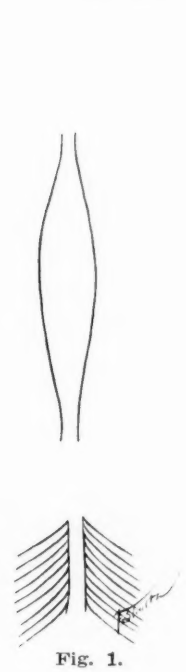

Fig. 1.

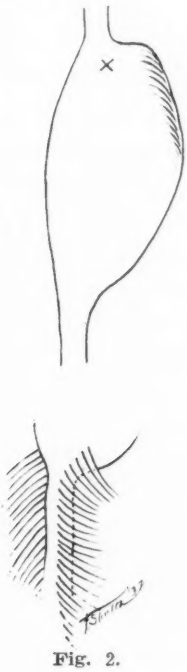

Fig. 2.

Fig. 3.

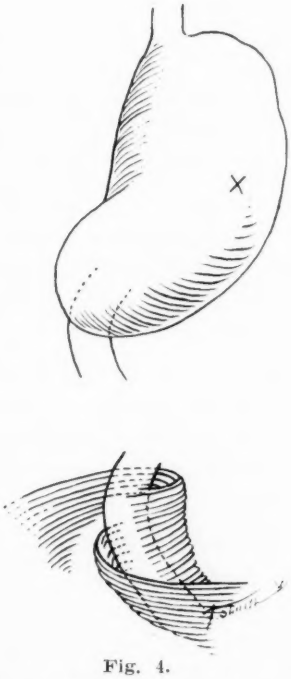

Fig. 4.

Fig. 5.

Figs. 1-5.—Diagrammatic representation of development and rotation of the stomach and duodenum from the primitive enteric tube in the embryo. (Figs. 1-4 viewed from the right side; Fig. 5 viewed from the anterior or ventral surface.)

These show the major enlargement as occurring in the esophageal, or cardiac, end of the stomach, and the primitive anterior and posterior mesogastrium of the pyloric end of the stomach and duodenum, as it is rotated into folds which later, by more or less complete fusion, fix the second and third portions of the duodenum after rotation is complete. It is by separation of these partially fused layers that proper mobilization of the duodenum is made possible and accomplished.

intelligently and clearly we must have an accurate understanding of the anatomy, including embryologic development, and of the physiology of the parts involved; so we shall first review briefly these phases, at the risk of some repetition of and encroachment upon the subject matter of other papers composing this symposium.

The stomach is first recognized in the embryo about the end of the third week, as a dilatation of the enteric tube, which lies vertically in the axis of the body. As this bulge rapidly enlarges, mainly posteriorly —that is, dorsad—it is supported, front and back, between vertical folds of mesogastrium. Primordial buds at the lower end of the bulge, where will eventually be duodenum, give rise, anteriorly, one to the liver and another to the head of the pancreas and common duct, and posteriorly, one to the body and tail of the pancreas. As the stomach pouch enlarges further, the dorsal portion gradually descends and rotates toward the left, while the ventral portion drops backward and slightly toward the right. In this way the superior part of the bulge becomes the cardiac and fundic portion of the stomach, the inferior part the pyloric end and the duodenum. Likewise the posterior portion becomes the greater curvature, the anterior portion the lesser curvature and duodenal cap, the left aspect the anterior surface of the stomach, and the right aspect the posterior surface. This process of rotation and what it entails is most important in surgery involving the duodenum, and should never be left out of account. Upon it depends both the fact that the blood supply of the duodenum enters from the inside of its curve—that is, medially —and that the lateral and posterior fixation of the duodenum, except where it passes under the mesenteric vessels, is accomplished by the fusion of the serosal coat on the right side of its embryonic anterior mesogastrium, with the serosal coat of the dorsal, or posterior, abdominal wall. For this reason, although the second and third portions of the duodenum, in adult life, appear to be retroperitoneal, they strictly speaking are not; and a line of cleavage between the partly fused serosal coats may usually be found, allowing the bowel to be rolled medially about one-half its circumference and somewhat downward, out of its bed in the maneuver spoken of as mobilization. We believe that lack of appreciation and understanding of this fundamental fact accounts for the difficulty in the performance of and poor results following operations involving the pylorus and duodenum in the hands of many surgeons.

There is one other fact that is often lost sight of, which has to do with the anatomy of the stomach, and to which we would here call attention, inasmuch as certain misconceptions seem to be common. The acid-secreting glands are situated in the fundus of the organ, not at the pyloric end. One of the arguments which has been widely employed to favor a resection of the pyloric end of the stomach over some form of plastic operation on the pylorus is that by so doing one removes a large part of the acid-forming area and thereby helps to control any tendency

toward hyperacidity. This is not the case unless an extensive resection is done. On the contrary, the glands in the pyloric portion of the stomach are apparently the same as, or similar to, the Brunner's glands in the duodenum, and their secretion is alkaline. Would it not seem logical, therefore, to preserve them and their secretion so far as possible?

Pylorospasm apparently may be produced by either local direct or distant reflex stimulation, the latter presumably through the vagus nerve. In either event, a vicious circle may be instituted, in which cause and effect of an ulcer near the pylorus seem to become hopelessly entangled. This confusion has led to much argument as to whether ulcer is caused by hyperacidity or whether hyperacidity is a result of ulcer. Into this controversy we do not intend to enter now. One thing seems obvious: that, to remedy the condition, the circle must be broken somewhere, somehow. If, mechanically, the pyloric sphincter is put completely out of commission, then certainly there can be no further spasm. This may be done simply by dividing the muscle entirely, and by so closing the necessary wound that the divided ends remain widely separated and therefore cannot reunite, or, more radically, by complete extirpation of the ring, followed by some type of reestablishment of gastrointestinal continuity. The only alternative to one or other of these procedures is a short-circuiting around this area, at least theoretically throwing it out of the path of active circulation of gastric contents. We qualify this last statement advisedly because it seems quite well established that unless the pylorus has become completely stenosed either by neoplasm or by contraction of scar tissue due to ulcer, material ingested into the stomach will endeavor to follow its normal channel, and to a considerable extent will succeed, even in the presence of a much larger auxiliary but unnatural outlet. This fact may play some part in the occurrence of marginal ulcer following gastrojejunostomy in the presence of a partially patent pylorus, the food-neutralized gastric contents passing to a large extent through the normal channel, thus allowing a high concentration of acid from the adjacent glands to come in contact with the jejunal mucosa at the new stoma. If one adds to this the indisputable fact that the duodenum is accustomed and acclimated to the reception of the acid contents of the stomach as they are expelled through the pylorus, does it not then seem reasonable and natural that normal anatomic relationships should be maintained in our choice of operations, where possible?

There is, however, one entirely independent factor which should modify this choice when we are dealing with an ulcer definitely gastric in origin, namely, the question of malignancy. The occurrence of neoplasms in gastric ulcer has been variously estimated at from 2 to 5 per cent all the way up to almost 70 per cent. Where estimates vary so widely, one person's guess is almost as good as another's. The important consideration is not so much the exact percentage number, but rather the fact

that this can and does occur, and that it may be quite difficult to recognize all cases in this group. Every effort should be made, therefore, to excise the ulcer with a good margin. If this can be accomplished in the course of some type of plastic operation, well and good; if not, then some form of resection which will permit of its complete elimination should be chosen. Due to the relative infrequency of duodenal carcinoma, this consideration need not influence one's choice of operation there.

Fortunately from the standpoint of this possibility of malignant degeneration, duodenal ulcers appear to be much more common than gastric ulcers; again the actual ratio varies considerably as given by different observers, but seems to average at about 3 to 1. This proportion is of interest to us from another angle as well; namely, that the duodenal ulcer lends itself much more readily to some form of pyloroplastic operation than does the gastric. It is also of importance that probably between 80 and 90 per cent of duodenal ulcers are located within an inch or less of the pyloric ring. In the case of the gastric ulcers, while probably 75 per cent or more occur in the pyloric end of the stomach, they may be anywhere up to two or two and a half inches away from the pylorus, a distance which renders the applicability of a pyloroplasty doubtful, but which still permits of a pylorectomy with gastroduodenal anastomosis.

Unfortunately a fairly large proportion of duodenal and pyloric ulcers occur either on the superior margin or posteriorly. Even a larger proportion of gastric ulcers occur on or very near to the lesser curvature. This automatically limits materially the field of utilization for the linear incision types of pyloroplasties—Heineke-Mikulicz, Mayo, and Horsley—but is no contraindication to the employment of the inverted horseshoe incision, sometimes called a gastropyloroduodenostomy —Finney. The latter is very much less limited in its applicability either by distance of the lesion from the pyloric ring or by its position on the circumference of the viscus.

The most potent bar to the employment of a pyloroplasty or gastroduodenostomy (and this is equally true of any type of pyloric resection), is the presence of dense scar tissue and adhesions binding the pyloric end of the stomach and the duodenal cap superiorly to the liver and posteriorly to the common duct, hepatic vessels, and the head of the pancreas. This may render the proper mobilization of the pylorus and duodenum, upon which the success of the operation is dependent, very difficult or utterly impossible. In such instances the use of a short-circuiting operation such as posterior gastroenterostomy becomes necessary. Fortunately also in such cases there is usually a very high grade of pyloric stenosis, which favors the proper functioning of such an anastomosis. To reiterate, it cannot be too strongly emphasized or too frequently stated that the successful result in pyloroplasty or gastro-

duodenostomy is directly dependent upon the complete mobility of the duodenum. Where this cannot be adequately attained, some other form of operation should be chosen.

Coming now to the actual technique of these operations, we will divide them into two natural groups: first, the plastic operations involving the simple division of the pyloric sphincter; and second, the operations involving the exclusion or total removal of the pyloric sphincter. The first group we will call pyloroplasties, the second group gastroduodenostomies.

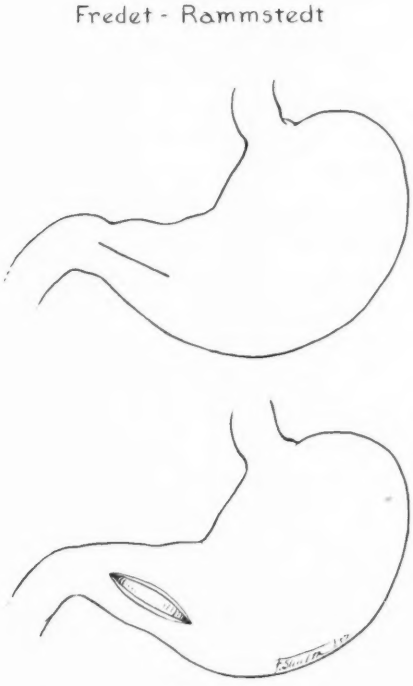

Fig. 6.

PYLOROPLASTIES

The first operation to be discussed in this group is one of the more recent contributions and one with a very limited field of application, but in its particular place it is universally accepted as the operation of choice. This is the Fredet-Rammstedt submucous pyloroplasty for congenital pyloric stenosis. First proposed by Fredet in 1907, it followed the principle of the much older Heineke-Mikulicz, in that following the division of the hypertrophied muscle band (but without incising through the mucosal lining, into the lumen of the gut), the linear longitudinal incision was transformed into a transverse wound by suturing the cut muscular and serosal layers, bringing the original ends of the horizontal incision together first to be the midpoint of the new vertical suture line, and continuing from there upward and downward until the defect

was completely closed. Such closure was frequently rendered difficult by the almost cartilaginous consistency of the hypertrophied muscle bundle, and also tended again to encroach somewhat on the lumen of the gut. Hence the modification suggested in 1912 by Rammstedt, which simply omitted all attempt at suturing and left the mucosa bulging through the elliptical defect in the pyloric muscle, has been almost universally adopted. This raw area may or may not be covered over by some fat from either the gastrohepatic or gastrocolic omentum as the operator may choose. The pylorus in an infant is best reached through a short right rectus incision, placed rather near the medial margin of the muscle

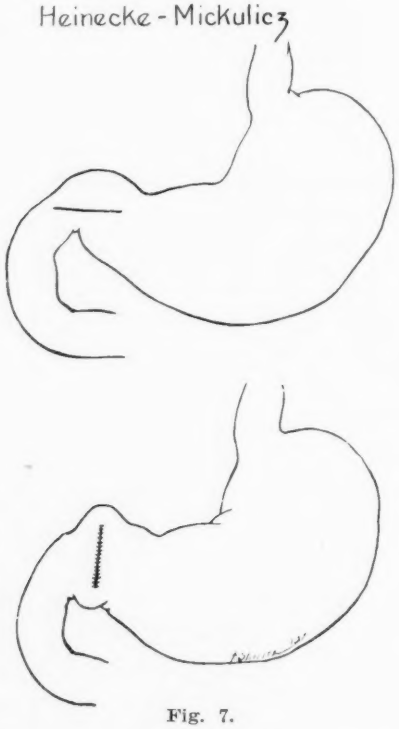

Fig. 7.

and not too high toward its costal insertion, remembering that the liver edge generally reaches from three to five centimeters below this landmark. The pylorus, being usually much more mobile in the infant than in the adult, can often then be delivered out of the wound, and the operation performed outside the abdominal cavity. After closure of the peritoneum with a running suture of fine catgut, the wound is best closed in anatomic layers with interrupted sutures of fine silk, for infant's tissues do not tolerate and absorb catgut very satisfactorily. The results of this operation are as near perfect as one could ask of any operative procedure.

Chronologically, the first plastic operation on the pylorus was reported from Heineke's Clinic in 1886. Virtually the identical opera-

tion was reported independently less than a year later by Mikulicz. Hence it has become known as the Heineke-Mikulicz pyloroplasty, the pioneer of all plastic operations on the pylorus. The description of the technique as given in excerpts from Fronmüller's original report of the first operation done by Heineke is as follows: ". . . A longitudinal incision was made in the anterior wall of the pylorus. . . . The lumen of the pylorus now opened proved to be so narrow as scarcely to admit a large knitting needle. After the longitudinal incision had been considerably enlarged on the stomach side as well as on the pyloric side, one could introduce the finger in either direction. . . . In order to remove the constriction . . . the longitudinal wound of the pylorus was drawn into the transverse direction and thus sutured transversely, in the vertical direction. In this manner the stomach angle of the wound was sewed to the duodenal angle and the anterior wall of the stomach was united to the anterior wall of the duodenum. The sutures were placed close together in a double row." Mikulicz's description of technique differs in no essential way from that just quoted except that he says: "If a fresh, possibly bloody or perforating ulcer is found, one turns his attention to this first." This at least suggests the possibility of the excision or cauterization of an ulcer in the course of such an operation, as well as an enlargement of the constricted pylorus. It also rather accurately suggests the limitations of this type of operation. An ulcer on the anterior surface of stomach or duodenum, if within an inch or less of the pylorus and if not too large, may easily be excised if, instead of a linear longitudinal incision, a long narrow elliptical incision be employed, with one limb of the ellipse encircling each side of the ulcer. If the ulcer is on the superior—that is, lesser curvature—side, or the inferior—greater curvature—side, this type of operation is virtually impossible and is therefore not indicated. If the ulcer is directly posterior, it may be possible, after the linear incision is made and the cut edges retracted, either to cauterize the ulcer from within the gut lumen, or better, to excise its edges and base, being careful not to penetrate the posterior muscular layer completely; and then by undermining the surrounding mucous membrane, bring it together with a running or buttonhole lock stitch of fine catgut, to cover this raw area over the excised base. The wound in the anterior wall is then closed in the original manner at right angles to the line of incision, either by a row of mattress sutures of fine silk, turning in the cut edges, and then reinforced by a second row of Lembert sutures of silk, or if one prefers, by a first row running mattress or Connell stitch of fine catgut, which likewise inverts the edges nicely, reinforced by a second row of interrupted or continuous silk. This may then be covered by a flap of gastrocolic or gastrohepatic omentum, or by a portion of the round ligament of the liver, if desired. Such reinforcement is particularly appropriate if one has been dealing with a perforated ulcer, since the stomach and

intestinal walls may be so edematous and friable as to make proper stitching most difficult, if not impossible. One practical point, which will make closure easier in any event, is to have previously freed the upper surface of the pylorus, as well as the cap and first portion of the duodenum from its attachment to the veillike suspensory ligament and the lateral border of the gastrohepatic omentum.

The Mayo modification consists of a somewhat longer and crescentic rather than linear incision, making it easier to excise an ulcer, if present.

The Horsley modification, 1919, stresses the excision of any ulcer present and emphasizes the fact that the incision, which is linear, should

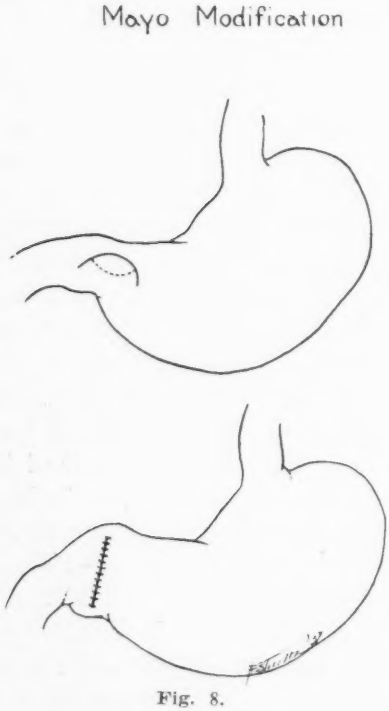

Fig. 8.

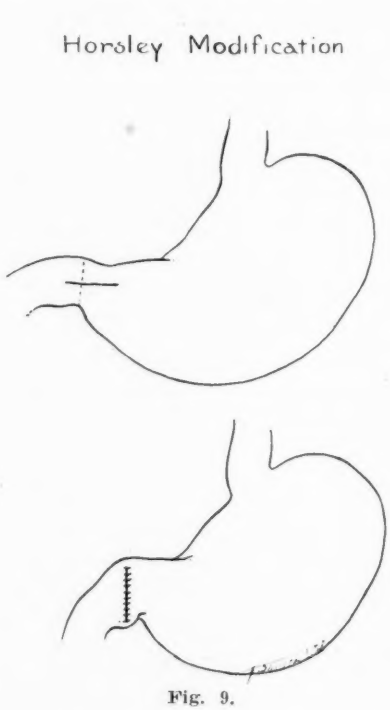

Fig. 9.

extend twice as far on the stomach as on the duodenal side of the pylorus, and never be over three inches in total length. In his closure, he is very careful not to include the pyloric mucosa in any stitches, or injure it by handling, as he feels such trauma is a potent cause of recurrent ulcer.*

In 1902, Finney first described his pyloroplasty, or, as it is sometimes called, "gastropyloroduodenostomy," a title which possibly better suggests its greater extent and wider application. It has since been modified somewhat by its originator and his associates. Such modifications have consisted mainly in methods of suturing and have not affected

*We have not included the so-called Judd pyloroplasty, which involves the resection of the anterior portion of the pyloric sphincter through an incision in the line of its fibers, and closure in a similar transverse (to the bowel) direction, because we feel that it is primarily a resection of muscle rather than a plastic operation in the true sense of the word.

the underlying principles of the operation. The abdomen is opened by a high right rectus incision, curving the upper end medially along the costal margin, if necessary, to gain proper exposure in cases where the duodenum and pylorus are lying in a high transverse position. Careful examination is then made of the local lesion and its suitability to this type of operation is determined. The superior margin of the duodenum just beyond the pylorus, and occasionally including it, is freed from any adhesions and from the supporting ligament running to the undersurface of the liver. This is done by a small incision along the duodenal margin, followed by peeling out the duodenum bluntly with the fingers, aided at times with gauze, or rarely by sharp dissection.

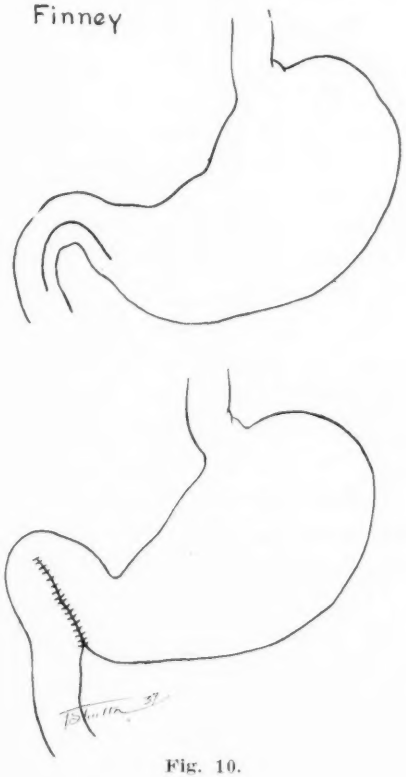

Fig. 10.

In this way practically the whole of the first and second, and even, if necessary, the third, portions of the duodenum may be readily mobilized with a minimal amount of bleeding. (The reasons for this have been discussed earlier.) After the pylorus and duodenum have been thoroughly freed, three guide and tractor sutures are placed: one at the upper margin of the pylorus; one in the wall of the stomach close to the gastrocolic omentum and about three inches from the pylorus, on the greater curvature; the third along the free border of the duodenum and a corresponding distance distal to the pylorus. By approximating these last two guides with slight traction downward and at the same time

supporting the pylorus by like traction upward on the one first placed, the walls of the stomach and duodenum should virtually fall in apposition for the placing of the posterior suture. This is of fine black silk (or catgut if preferred); it is usually most easily placed with a fine curved intestinal needle. The suture which we commonly employ is a simple continuous one, beginning at the lower margin of the pylorus and running downward to the traction sutures, and inserted well back toward the vessels of the greater curvature of the stomach and mesentery of the duodenum, endeavoring to catch such vessels as are visible in or on the wall of stomach and bowel, so as to reduce the amount of bleeding to be encountered later on when the incision is made through these walls. When this stitch has been satisfactorily placed, it will leave about three-quarters of the circumference of the duodenum for the placing of the mattress sutures. These, also of fine black silk, are then inserted, starting from the lower end of the posterior suture just described, and overlapping that end a bit so as effectually to seal this angle. The mattress sutures are placed far enough out from the posterior row, so as to include any ulcer which may be situated on the anterior or upper portion of the duodenum to allow of its excision later. These mattress sutures are next loosened and retracted, one-half downward, the other half upward, and thus held well out of the operative field. By inserting the anterior stitches before opening the stomach and duodenum, they can be placed just where wanted so much more easily. (As a matter of fact the author does not follow this step of the originator, but opens the bowel without the previous insertion of anterior stitches; then, when the time comes for closure, doing so with two rows of continuous stitches as posteriorly; the first a Connell suture of fine catgut, the second an overlying continuous suture of fine silk.) The general abdominal cavity is now thoroughly packed off from the region of operation and the wound edges protected by wet pads before making the incisions into stomach and bowel. Beginning from below, on the stomach side about one-half centimeter from the lower end of the posterior suture line, and being careful to include all layers of the stomach wall, we carry the incision upward and, through the pylorus, down into the duodenum, in the shape of a narrow inverted U, to a point opposite the start on the stomach side. This will give approximately a two and one-half inch incision in the anterior wall of each viscus connected by a division of the pyloric sphincter. If there is an ulcer on the anterior or superior portion of the pylorus or duodenum it should be excised, ample room having been allowed for this in placing the mattress sutures, as stated above. If the ulcer is situated on the posterior wall of pylorus or duodenum, it will be somewhat more difficult of excision. But this can be accomplished by removing a triangular piece of the duodenal wall (including pyloric muscle or not, as indicated or desired), apex downward toward the posterior suture. If such a procedure is necessary, we complete the

closure of the defect in the posterior wall, so made, before that of the pyloroplasty proper. A running suture of fine catgut is started at the point from which the apex of the triangular piece was removed, and the mucosa and muscular layers of the stomach and duodenum are brought together. We find it advisable to use a buttonhole lock stitch for this, as it adapts itself best to the conditions. The restored superior wall of the duodenum is then retracted downward and a continuous fine silk reinforcing suture is placed in the serous surface, running upward and over the superior curvature as it has been reconstructed. When these two sutures have been completed, we have returned to the status quo ante. (If it does not seem advisable or feasible to excise such a full thickness portion of the superior or posterior wall, as for instance in the presence of dense adhesions to or apparent perforation into the head of the pancreas, the ulcer may be removed, destroyed, or covered over as indicated in the description of the Heineke-Mikulicz pyloroplasty.) Looking through the incisions in the anterior walls, into the opened stomach and duodenum, we start a fine catgut suture at the lower angle posteriorly and make a continuous through-and-through buttonhole stitch, approximating the cut edges of mucous membrane and muscularis of stomach and duodenum. This gives a smooth closure of the posterior wall and controls all bleeding there. The bleeding points of the anterior wall of both stomach and duodenum should be individually clamped and tied. Sometimes at the upper end of the posterior suture line, where the fibers of the pyloric sphincter have been cut across, there may be some redundancy of tissue. If this seems excessive, it may be trimmed off, being careful not to cut the posterior silk suture, first laid. We have found, however, that this ridge will rapidly flatten out and disappear if left alone. There is, at this stage of the operation, a posterior wall which is held solidly by a serous continuous suture of silk and a muscular and mucosal continuous suture of catgut. The posterior line having thus been completed and all bleeding on the anterior edges having been checked, the mattress sutures previously laid are drawn taut and tied. This row is reinforced by a second one of Lembert sutures of fine silk, completing the anastomosis. (Personally, as indicated above, we complete the anterior closure by a continuous Connell suture of fine catgut, which is started at the lower angle, and then cover this with a continuous suture of fine silk, also started at the lower angle.) The anterior suture line may then be reinforced, if desired, by fat from gastrocolic or gastrohepatic omentum, or by bringing up the greater omentum and tucking it well up in the angle between the undersurface of the liver and the superior portion of the duodenum. The abdominal wound is closed in layers, without drainage.

RESECTIONS WITH GASTRODUODENOSTOMY

The first successful resection of the pylorus, which was completed by an end-to-end anastomosis of stump of stomach to stump of duodenum

(the first gastroduodenostomy), was done by Billroth in 1881, and a report of it, together with two other similar cases, was published by Wölfler later that same year. Curiously enough, one of the great bones of contention concerning the technique of the anastomosis had then already been unearthed: whether the stump of the duodenum should be set into the stump of stomach at the greater or lesser curvature border. The reasons which Wölfler gave in this original report for switching to the lower position for implantation seem to us to be equally potent today. "In the second case, due to dilatation of the stomach, and the somewhat changed direction of the incision, the occlusion suture from the greater curvature upward formed a cul-de-sac which was exaggerated by the position of the anastomosis, high on the lesser curvature. The third resection was based on my experiments on the cadaver, which

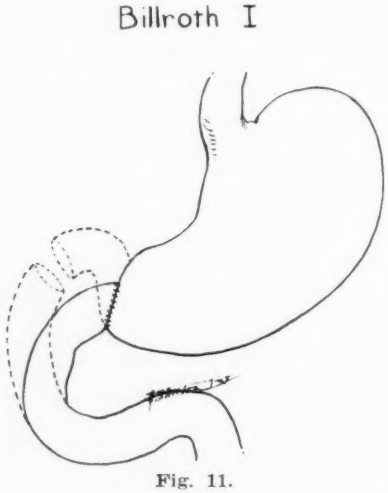

Fig. 11.

showed that we should attach the duodenum at a point near to the greater curvature instead of near the lesser curvature. This was for the purpose of avoiding a diverticulum of the fundus of the stomach as well as for providing more favorable conditions for the outflow of stomach contents. . . . If it is feared that by joining the duodenum at the greater curvature a diverticulum may form at the lesser curvature, it may be more satisfactory to make the incision obliquely through the stomach wall from above and from the left downward and to the right. Under all conditions the oblique division of the stomach appears to be the most satisfactory for avoiding diverticula. In future cases, therefore, Professor Billroth would, whenever possible, insert the duodenum into the greater curvature." Mechanically this placement seems more preferable to us and is used whenever an end-to-end anastomosis is employed. W. J. Mayo also strongly recommends it, where the ratio of difference between stomach and duodenal orifices is greater than 2 to 1;

where less than that, the larger stomach may be pleated, and thereby reduced, by taking two stitches in it to every one in duodenum, rendering possible without reduction, a direct anastomosis. Another method for meeting the disparity between the two stumps involves a longitudinal incision in the anterior wall of the duodenum running back about an inch from the cut margin, which materially enlarges the open end and lessens the inequality with the stomach. We feel, however, that this endangers the blood supply of the terminal portion of the duodenum somewhat and consequently makes sloughing at the suture line posteriorly more likely. Horsley has been a proponent of setting in the duodenum at the lesser curvature, for he feels that there is less disturbance to the main nerve control of the left vagus, which is distributed along the lesser curvature, and that also this arrangement better maintains the sulcus gastricus or Magenstrasse for the emptying of fluids. There has been much reference to the "dangerous angle," where the reduction suture in the stump of stomach merges into the circular suture which attaches the duodenal stump, but we can see no reason why a leak here should occur any more readily than elsewhere in the suture line, provided there is no sloughing. This brings up the point of preservation of the blood supply of the duodenal stump, which we fear is often imperiled by too great effort on the surgeon's part to clean all gurry off the serosa before the anastomosis is made and by the use of too many tissue-constricting stitches in his effort to avoid the very thing which he is thereby fostering. Two rows of stitches if properly placed should render any bowel suture gas and water tight; more rows than that tend unduly to endanger blood supply and to invert an unnecessarily large flange of tissue.

In the technique of the pylorectomy, we follow pretty closely the principles laid down by W. J. Mayo in his article published in 1923. "The success of the procedure depends on early ligation of the gastric artery as close as necessary to the coeliac axis, depending on the location of the growth in the stomach (and the amount of that organ to be removed). After separating the gastrohepatic omentum from the undersurface of the liver, the distal end of the gastric artery is held taut and the artery, glands, fat and underlying structures are dissected from the lesser curvature toward the pylorus, the lateral vessels being caught and tied in succession as the holding bands are cut." The gastrocolic omentum has previously been freed from the greater curvature, opening the lesser peritoneal cavity. The stomach is then divided between rubber-shod clamps applied above the growth and somewhat obliquely, division usually being made with the cautery. A running mattress suture of catgut is then started at the upper end on the lesser curvature and extended downward until the remaining unsewed portion of the stump of the stomach is only slightly larger than the apparent diameter of the duodenum. The stitch is then locked

and laid aside. A continuous running suture of fine silk is then started, also at the lesser curvature, covering and turning in the catgut suture just completed; it is carried the same distance and also locked and laid aside. The distal stump of the stomach is now raised and turned back toward the right, and the posterior portion of the pylorus and immediately adjacent duodenum freed from the structures behind, particular care being taken not to injure the middle colic artery, the head of the pancreas, the common duct, and the hepatic vessels. Using this free end of stomach as a handle now, we approximate the posterior walls of the duodenum, just below the pylorus, and the remaining open portion of the stump of stomach by a continuous running suture of fine silk, which is tied at the lower margin. The duodenum is then severed about one-half of a centimeter proximal to this suture line. The catgut stitch, which has been used to reduce the lumen of the stomach

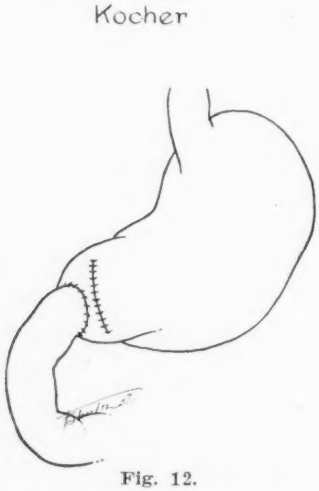

Fig. 12.

stump and then laid aside, is now continued as a buttonhole lockstitch uniting muscularis and mucosa of stomach and duodenum to complete the posterior line, and, when the lower margin is reached, is still continued as a Connell suture up the anterior wall to the superior margin of the anastomosis, where it is tied with knot inverted. The running silk suture from above, which was also locked and laid aside, is now continued downward, anteriorly, making the second suture row here, and completing the anastomosis when tied at the greater curvature margin. The rents in gastrohepatic and gastrocolic omentum are now repaired, and the abdomen closed without drainage. But, as Mayo cautions, "This operation should not be forced. If it cannot be done easily, one of the other methods of gastrectomy should be applied. . . . The Billroth I operation is again coming to the front, not only for cancers located in the pyloric end of the stomach, but also for many ulcers on the lesser curvature. Instead of removing an unneces-

sarily large area of the stomach as in the other forms of partial gastrectomy, it removes the disease, saves the normal stomach, and restores the gastrointestinal canal by uniting duodenum to the amputated end of the stomach."

In the Kocher modification, reported in 1893, the stump of the duodenum, following the pylorectomy and complete closure of the stump of the stomach, is implanted into the posterior wall of the stomach about one to one and one-half inches from its closed end, and near the greater curvature margin. This was suggested in order to eliminate the dangerous angle. So far as we know, it is rarely, if ever, used today.

Pursuant to the principles of his pyloroplasty and merely enlarging on them somewhat, Finney, about 1920, began using an end-to-side gastroduodenostomy following pylorectomy. After employing this

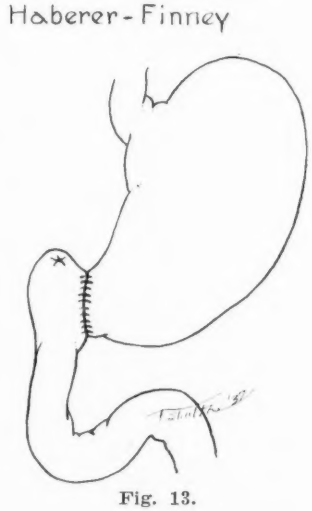

Fig. 13.

method satisfactorily several times, and while an article was in preparation to report it, one by von Haberer was published in 1922 describing an identical procedure which he had evolved independently. Finney's article appeared in 1923, so we have called this terminolateral gastroduodenostomy the Haberer-Finney modification of the Billroth I. Its advantage over the latter is that the surgeon is not limited in the size of the anastomotic opening by the diameter of the duodenum; hence the danger of constriction by circular scar contraction is completely eliminated. Also there is less danger of interference with circulation in the duodenal stump, with consequent sloughing and leakage. Its disadvantage is the extent of mobilization of the duodenum necessary to its proper performance; this objection is more apparent than real, however, if the principles laid down in the first part of this paper are remembered. This mobilization should be done before the pyloric resection is instituted. The pylorectomy is then done

as described for the Billroth I, the narrowing of the lumen of the stump of the stomach being carried out or not as the operator sees fit and to such extent as he desires. (We have arbitrarily adopted as our standard a lumen for the completed anastomosis which will readily admit the tips of three fingers—approximately two and one-half inches.) The duodenum is now severed and the stump inverted with a purse-string suture (much as the stump of the appendix in appendectomy), and this is reinforced with several mattress sutures of fine silk. The posterior wall of the gastric stump is then applied to the side of the duodenum, about three-quarters of an inch below its closed stump and united with a continuous running suture of fine silk, serosa to serosa. One may then lay an anterior row of silk mattress sutures, as in the original pyloroplasty, and retract them upward and downward out of the way, or proceed to open the duodenum, without this step. Bleeding points

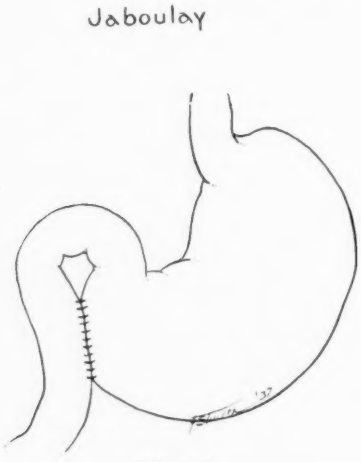

Fig. 14.

are clamped and tied, individually. Two sutures of fine catgut are now started in the center of the posterior wall, uniting muscularis and mucosa of stomach and duodenum by a buttonhole lockstitch, one running upward, the other downward. When the angles are reached, these are continued downward and upward as a Connell stitch in the anterior walls, until they meet at the center; here they are tied, throwing the knot inside. The mattress sutures of silk, previously laid and drawn aside, are now tightened and tied, and reinforced with intervening Lembert sutures of fine silk. If this step has been omitted above, a silk suture is started at either the upper or lower angle, and a running suture with it completes the anterior layer. The abdominal wound is closed without drainage.

There is one other type of gastroduodenostomy, a subpyloric side-to-side anastomosis which was first suggested by Jaboulay in 1892. This has a rather restricted field of application and is probably very infre-

quently used, but has certain merits, we feel, which might render its more frequent consideration advisable. To those who believe that marginal ulcers following gastrojejunostomy are a real hazard, and that both anatomy and physiology of digestion are better maintained by having stomach empty into duodenum rather than jejunum, we recommend it for trial in those cases where dense scarring and adhesions binding pylorus to undersurface of liver, to pancreas, and to common duct render proper mobilization of the pylorus and first portion of duodenum impossible for pyloroplasty. In many of these cases it is quite easy to free the second and third portions of the duodenum so that it can be approximated easily to the greater curvature of the stomach anterior to the attachment of the gastrocolic omentum without any tension. Here a lateral anastomosis is performed after the technique just described for the Haberer-Finney gastroduodenostomy—two-layer suture of catgut and silk. This short-circuits below the pylorus and ulcer, if present, as does a gastrojejunostomy. It does away with the possibility of a kink at the site of anastomosis, a constriction by, or other difficulties with, a short transverse mesocolon, or a distended proximal loop instituting a vicious circle. And we have never heard of a marginal ulcer following this operation. In very thin individuals with a maximum degree of ptosis, it may be contraindicated from the possibility of a gastromesenteric ileus, which would still obstruct the bowel below the new stoma.

So much for the history of and the technique in performing the various pyloroplasties and gastroduodenostomies. Now what are their advantages and disadvantages in comparison with other forms of gastrointestinal anastomoses? First, they admit of the thorough examination of the lesion and adjacent lining of both stomach and bowel, together with the local removal of that lesion and consequent control of hemorrhage from it. This a simple gastrojejunostomy can in no wise do; a resection with a Polya type of anastomosis can do equally well. Second, when confronted by a perforated ulcer near the pylorus, some form of pyloroplasty is usually applicable, again allows of excision of the ulcer, and limits the extent of the operative field to the locality of the origin of the soiling, which may or may not make a difference. If a gastrojejunostomy is done, we are bound to spread things in turning up the omentum and transverse colon to get to Treitz's fossa. Third, a pyloroplasty or gastroduodenostomy, without resection, enlarges the opening of stomach into duodenum, and in all but the Jaboulay type, divides the sphincter and puts it completely out of commission in so doing, thus allowing free transfer back and forth of acid stomach and alkaline duodenal secretions to neutralize each other, and further lowering the acid manufactured by the stomach by allowing it to empty more rapidly. In gastrojejunostomy this is comparably true only when the pylorus is completely occluded; otherwise, though the

anastomotic stoma be much larger than the pylorus, and though it be situated in a position to give, apparently, dependent gravity drainage, a certain amount will go through the natural channel, that amount being determined seemingly only by the degree of patency of the pylorus. In so doing, its acid content neutralizes the alkalinity of the duodenal secretions so that there is correspondingly less protection afforded the mucosa in the region of the new jejunal stoma, and the passage of such acid material as comes directly through it renders the incidence of marginal ulcer that much higher. This would seem to explain the fact which most surgeons recognize, that the greater the patency of the pylorus, the less satisfactory the results from gastrojejunostomy. Fourth, pyloroplasty does not remove the ulcer-bearing area. Neither does gastrojejunostomy. Only a pylorectomy does this, and we question whether such a reason is adequate justification for the constant employment of the more radical procedure. Granted that it is valid reasoning, however, we believe that gastroduodenostomy offers a better type of reconstruction than gastrojejunostomy of Polya or others. Fifth, pyloroplasty does not decrease the acid-forming area of the stomach; neither does simple gastrojejunostomy. Only a very extensive resection of the stomach will accomplish this, and we feel sure such operation is rarely justified in any case of simple ulcer. Sixth, pyloroplasty is claimed by some to be technically much more difficult than simple gastrojejunostomy. This we feel is at least debatable. We will grant that it has certain limitations, depending mainly on mobility of duodenum, beyond which it certainly should not be pushed. On the other hand, if the principles of mobilization are thoroughly understood and practiced, the field of applicability will be found quite wide. And also, there are cases where a short, excessively fat transverse mesocolon renders the performance of a posterior gastrojejunostomy technically exceedingly difficult or altogether impossible. The great advantage which it holds is that it is much more universally taught and hence better understood. Anything which is not thoroughly comprehended appears more difficult. Seventh, there is much more bleeding and soiling with pyloroplasty. This is true because most surgeons use clamps in doing gastrojejunostomies. But is all the disadvantage on one side here, and does it really make much difference? When stomach or bowel is opened without clamps having been previously applied, we see the bleeding points, clamp them, and tie them; we do not depend on suture lines for hemostasis. The result is that we have not been bothered by cases of postoperative gastric or intestinal hemorrhage. Apparently such things do occur at times after other types of operations, for we have been asked on numerous occasions how we treat them. As for the soiling, pyloroplasties are done for either gastric or duodenal ulcers, near the pylorus and presumably with a certain degree of pyloric stenosis; they are not done for car-

cinomas. With ulcers of this type and in this location we almost invariably have a fairly high degree of free acid, usually considerably more than normal. We have repeatedly shown, at least to our own satisfaction, by cultures taken from both stomach and duodenum at the time of operation, that a stomach properly prepared by fasting and lavage will sterilize itself within twenty-four hours so far as pathogenic bacteria are concerned; we usually demand a forty-eight-hour period of preoperative preparation. From all of this we can reasonably conclude, we believe, that the hemorrhage may not be entirely undesirable after all, and the soiling more imaginary than real. So far as forms of anastomoses following pylorectomy are concerned, soiling and hemorrhage should not differ whether gastroduodenostomy or some other method be used. Conversely, it is the contention in certain quarters that the trauma done to mucosa by the ill-advised or improper use of clamps may be a potent factor in the recurrence of ulcer. Partly for this reason, partly for those given above, we rarely use compression clamps when doing a simple posterior gastroenterostomy. Eighth, one is limited in the extent of resection by employment of a gastroduodenostomy for closure. This is mainly, though not entirely, true. The degree of mobility of duodenum is sometimes surprising; we have twice joined esophagus to duodenum following complete gastrectomy; once end-to-end, once end-to-side. In the main, though, a terminolateral gastrojejunostomy is easier and preferable after extensive resection.

In conclusion, it is only fair to say that we will admit that we are prejudiced in favor of pyloroplasty and gastroduodenostomy, but we hope not unreasonably so. We do strongly advocate the more general understanding of the underlying principles and technique involved, in the belief that such knowledge will furnish further weapons in the armamentarium of the surgeon when he is called upon to face the fascinating problems presented in gastroenterologic surgery.

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SHOULD GASTRIC RESECTION BE DONE FOR DUODENAL ULCER?*

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MY INTEREST in the problem of whether gastric resection should be done for duodenal ulcer dates from that time in the early 1920's when Finsterer, visiting various surgical clinics in the United States, strongly advocated gastric resection as a routine method of treating duodenal ulcer in order to eliminate gastrojejunal ulceration. A similar viewpoint had been taken by Lorenz, another Viennese surgeon. Although it had been the custom in the Mayo Clinic as early as 1905[14] to perform partial gastrectomy in the treatment of large, calloused gastric ulcers because of the possibility of the lesion's being malignant, the more conservative procedures of gastroenterostomy or excision of the duodenal ulcer, with plastic operations involving the lower portion of the stomach and the duodenum, had been the surgical procedures of choice for patients with duodenal ulcer who had failed to obtain relief of symptoms on a medical regimen.

GASTROJEJUNAL ULCERATION

My recollection is that, at the time in the early 1920's of which I have spoken, Finsterer's main reason for advocating gastric resection for duodenal ulcer was that it was followed by reduction in the incidence of gastrojejunal ulcers to 1 per cent or less, in contrast to a reported incidence of 10 per cent subsequent to gastroenterostomy performed in Austria. The reason for this reduction in the occurrence of gastrojejunal ulcer was stated to be that achlorhydria occurred subsequent to gastric resection and hence recurring ulceration, gastrojejunal in character, could not take place. However, since the risk of partial gastrectomy was greater than that of gastroenterostomy, and since in partial gastrectomy the considerable part of the stomach that was removed, when examined by the pathologist, usually did not give evidence of any particular disease, and further, since the incidence of recurring ulcer after the conservative operations of gastroenterostomy or pyloroplasty had been followed in many clinics by an incidence of recurrent ulceration of not more than 4 per cent, little enthusiasm was aroused in the United States for partial gastrectomy in the treatment of duodenal ulcer. There were, however, two groups of surgeons in

*Read before the meeting of the Western Surgical Association at Kansas City, Mo., December 11 and 12, 1936.
Received for publication, December 29, 1936.

two separate areas of the United States, who had adopted the procedure. One of these groups had adopted it, since in their experience a relatively high incidence of gastrojejunal ulceration occurred following more conservative procedures.[10, 11] Their patients were, for the most part, of one race in which the percentage of intermarriage is exceedingly high. In the years that followed, largely as a result of the interest of these two groups of men who, in their experience, had been able to reduce the incidence of gastrojejunal ulcer in their cases to 3.1 per cent[3] as a result of the adoption of partial resection for duodenal ulcer, increasing interest in partial gastrectomy for duodenal ulcer appeared.

With the accumulation of larger series of patients on whom partial gastrectomy had been performed for duodenal ulcer, it became apparent that ulceration did recur even after subtotal gastrectomy. Usually the patients were found to have persisting free hydrochloric acid in the gastric content, and the erroneous conclusion was drawn that an insufficient amount of stomach had been removed. This opinion later was modified in this country, for in 108 cases in which partial gastrectomy or subtotal gastrectomy was performed for duodenal ulcer, relative achlorhydria occurred in but approximately 56 per cent.[6] Of greater significance, it seems to me, was the fact that in 44 per cent of the cases hydrochloric acid persisted or recurred in gastric secretion, and in nine cases gastrojejunal ulceration developed. In taking that reported series of 108 cases as a group, the incidence of gastrojejunal ulcer following partial gastrectomy was 8.3 per cent.[7] With the general recognition of the fact that gastroenterostomy carried a much lower surgical mortality[2, 13, 15, 27] than partial gastrectomy,[3] and of the fact that in our experience at the Mayo Clinic, as well as in the reports of other surgical clinics, gastrojejunal ulcer appeared in approximately only 3.2 per cent of cases,[2] we could not see the necessity for the routine performance of partial gastrectomy for primary duodenal ulcers on a comparative basis of formation of gastrojejunal ulceration. In this connection, it is worth while calling your attention to the report of a collective investigation,[13] in 1928, into the after-history of gastroenterostomy by the British Medical Association in respect to patients operated on in various parts of the British Empire during the period 1920 to 1924, inclusive. Quoting from this report: "Secondary gastrojejunal ulcer occurred in 2.8 per cent of 744 cases in which gastroenterostomy was performed for duodenal ulcer. . . . The postoperative mortality was 5 per cent. . . . The results of the operation were satisfactory in about 90 per cent of the cases."

GASTRITIS

The next wave of enthusiasm favoring partial gastrectomy for duodenal ulcer took its origin following the work of Konjetzny, Puhl, and

others who emphasized the high incidence of gastritis associated with duodenal ulcer found among German surgical patients; and it was thought by these observers that gastritis was the forerunner of the development of the duodenal ulceration. This high incidence of ulcerative hemorrhagic gastritis, stated to be characteristic of from 99 to 100 per cent of German patients operated on for duodenal ulcer,[8, 9] led Snell and me, in 1931, to visit various surgical clinics in Germany, Austria, and Hungary. In studying the resected portions of the stomachs of patients operated on for duodenal ulcer in these countries, as well as specimens previously removed by Schmieden at Frankfurt, Snell and I were impressed by the high incidence of gastritis present in the German cases in contrast to the very low incidence of gastritis associated with duodenal ulcer among patients on whom I had operated at the Mayo Clinic. These observations were published in a series of papers in the years 1931 to 1933,[4, 18, 20, 21, 22, 24] and the accuracy of the observations was confirmed by Sebening,[18] of Schmieden's Clinic, who spent several months in study at the Mayo Clinic. The very infrequent occurrence of gastritis among patients operated on at the Mayo Clinic for duodenal ulcer, in comparison with those operated on at the German clinics, is probably explained on the basis of so-called geomedical variation of types of lesions and by the part played by racial factors in these differences, which has been commented on by von Haberer and more recently by Schittenhelm. The latter, gathering data from various parts of Germany, has emphasized the fact that disease frequently presents different characteristics, even in localities where it first appeared. Quoting briefly from Schittenhelm's report: "Apoplexy, atherosclerosis, and thrombosis are more frequent at Basel than at Kiel. Gastric and biliary disorders likewise present distinct regional differences—the part played by racial factors in these differences is as yet unknown to science." Further lending support to the geomedical differences in gastritis associated with duodenal ulcer is the fact that in a paper published by Aschner and Grossman, gastritis was found in approximately 60 per cent of the portions of stomach resected for duodenal ulcer, in contrast with its presence in less than 12.5 per cent of the series of resected gastric specimens on which I reported from the Mayo Clinic where, in a series of cases, partial gastrectomy had been performed for duodenal ulcer.[4, 24] The corollary of this would seem to be, therefore, that since, in our experience, gastritis has been such an infrequent accompaniment of duodenal ulcer, any argument directed toward the value of removing such areas of gastritis in the performance of partial gastrectomy for duodenal ulcer could not be used in favor of such a procedure in the cases in which we usually operate.

PARTIAL GASTRECTOMY FOR DUODENAL ULCER

Having discussed and eliminated, I believe, the factor of gastritis as an indication for partial gastrectomy in the cases in which we have operated, and having stressed the low incidence of recurring ulceration in several series of cases following gastroenterostomy in contrast to a much higher incidence of recurring ulceration following partial gastrectomy in another series of cases, the important matter to be settled would appear to be *just what partial gastrectomy accomplishes in a better fashion than either gastroenterostomy or pyloroplasty.* That, it seems to me, can be answered rather briefly in the statement that it accomplishes greater reduction of free hydrochloric acid in the gastric

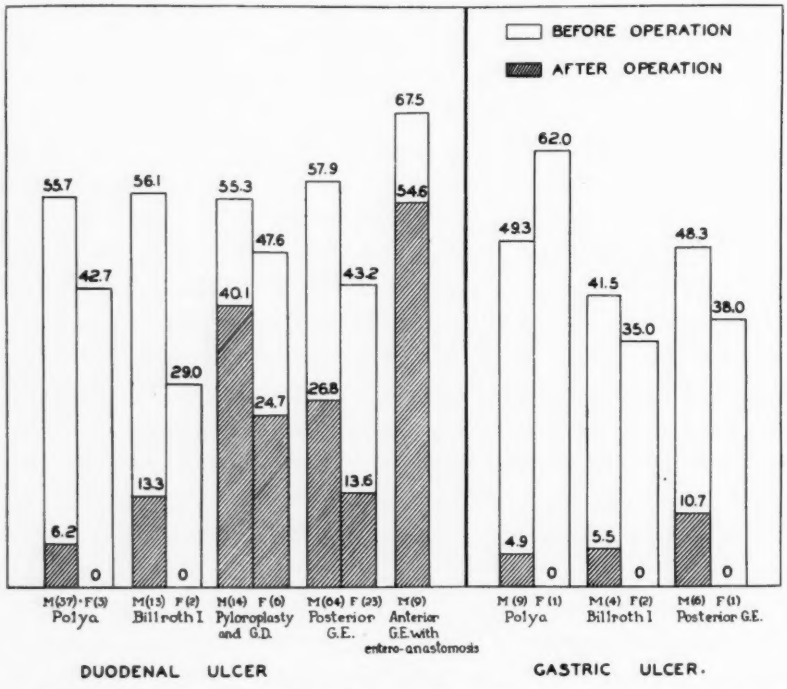

Fig. 1.—Mean (M) and free (F) gastric acidity, before and after operation in 194 cases.

secretion (providing the Polya type or Hoffmeister-Polya type of anastomosis is made) than does gastroenterostomy or pyloroplasty (Fig. 1). Although relative achlorhydria will more frequently occur following the Polya type of partial gastrectomy than following gastroenterostomy, yet it does occur following gastroenterostomy in some cases even if patients had high preoperative gastric acidity (Table I).[23] Of equal interest is the relative infrequency, in my experience, with which relative achlorhydria is obtained after gastric resection for duodenal ulcer when the Billroth I type of anastomosis is made; in other words, when the end of the stomach is sutured to the duodenum after resection of half or two-thirds of the stomach (Table II). This is in rather marked

TABLE I

RELATIVE ACHLORHYDRIA OCCURRING IN SOME CASES OF DUODENAL ULCER AFTER GASTROENTEROSTOMY

CASE	AGE, YEARS, AND SEX	DURATION OF SYMPTOMS	CHARACTER OF ULCER	PREOPERATIVE ACIDITY		HISTAMINE INTERVAL, MINUTES 10 20 30 40 50 60 70	POSTOPERATIVE ACIDITY	
				TOTAL	FREE HCl		TOTAL	FREE HCl
1	24 F	3 years	Subacute perforating with obstruction	40	34		14	0
2	38 M	20 years	Subacute perforating	62	50		12	0
3	48 M	12 years	Subacute perforating obstructing	76	70	Total 26 48 70 80 92 76 100 Free HCl 16 42 62 74 86 70 96	8	0
4	35 M	20 years	Acute perforating	100	80		14	0
5	47 M	5 to 6 years	Subacute perforating	118	100		10	0
6	47 M	35 years	Chronic (?)	60	40		16	0
7	48 F	6 years	Subacute perforating	74	60		9	0
8	44 M	12 years	Subacute perforating	64	54		12	0
9	50 F	10 years	Recurring	42	30		14	0

TABLE II

THE INFREQUENT OCCURRENCE OF RELATIVE ACHLORHYDRIA WHEN BILLROTH I-HABERER ANASTOMOSIS FOLLOWING PARTIAL GASTRECTOMY AND PARTIAL DUODENECTOMY IS PERFORMED FOR DUODENAL ULCER

CASE	AGE, YEARS, AND SEX	DURATION OF SYMPTOMS	CHARACTER OF ULCER	ACIDITY			
				PREOPERATIVE		POSTOPERATIVE	
				TOTAL	FREE HCl	TOTAL	FREE HCl
1	49 M	15 years	Subacute perforating hemorrhagic duodenal	46	32	18	8
2	56 M	8 years	Duodenitis	62	52	8	0
3	33 M	17 years	Gastrojejunal ulcer healed; duodenal	50	38	16	0
4	47 M	15 years	Perforating duodenal	70	64	54	40
5	32 M	10 years	Multiple duodenal with duodenitis	96	80	40	36
6	59 M	30 years	Chronic bleeding duodenal	40	20	32	20
7	35 M	14 years	Multiple subacute duodenal	34	24	56	44
8	27 M	5 years	Multiple chronic duodenal with duodenitis	88	78	28	20

contrast to the changes in acidity which follow similar procedures carried out in the treatment of gastric ulcer (Table III). Although I do not wish to discuss localized gastric ulceration in this paper, I do wish to say that the two lesions, that is, duodenal ulcer and gastric ulcer, should be sharply differentiated, not only because of their pathologic variations but because of the difference in their physiologic chemical

TABLE III

RELATIVE ACHLORHYDRIA FOLLOWING PARTIAL GASTRECTOMY OF BILLROTH I TYPE

CASE	AGE, YEARS, AND SEX	DURATION OF SYMPTOMS	CHARACTER OF ULCER	ACIDITY			
				PREOPERATIVE		POSTOPERATIVE	
				TOTAL	FREE HCl	TOTAL	FREE HCl
1	53 M	7 months	Gastric	56	44	6	0
2	55 M	9 months	Chronic hemorrhagic perforating gastric	70	58	10	0
3	57 M	4 months	Ulcerating gastric lesion	64	52	8	0
4	49 M	3 months	Chronic gastric	52	40	60	0
5	57 M	6 weeks	Subacute perforating gastric and duodenal	54	30	8	0
6	58 M	4 years	Chronic gastric	28	16	36	22
7	50 M	30 years	Subacute perforating gastric	6	0	12	0
8	55 F	15 years	Perforating gastric	52	40	10	6

responses to the same types of surgical operation, particularly as regards gastric acidity. When partial gastrectomy, either of the Polya or of the Billroth I type, is performed for gastric ulcer, relative achlorhydria occurs almost without exception (Table IV), but only in ap-

TABLE IV

RELATIVE ACHLORHYDRIA FOLLOWING PARTIAL GASTRECTOMY OF POSTERIOR POLYA* TYPE FOR GASTRIC ULCER

CASE	AGE, YEARS, AND SEX	DURATION OF SYMPTOMS	CHARACTER OF ULCER	ACIDITY			
				PREOPERATIVE		POSTOPERATIVE	
				TOTAL	FREE HCl	TOTAL	FREE HCl
1	47 M	2½ years	Subacute perforating gastric	76	60	4	0
2	58 M	4 years	Multiple gastric	48	30	20	0
3	44 M	8 years	Recurring subacute duodenal and gastric?	46	34	0	0
4	58 M	Several months	Subacute perforating gastric	60	42	10	0
5	56 M	1½ months	Subacute gastric perforating ulcerating			8	0
6	57 M	25 years	Obstructing gastric	40	30	5	0
7	40 F	31 years	Chronic gastric; chronic duodenal	38	24	4	0
8	58 M	3-4 years	Chronic perforating gastric	60	52	5	0

*Hoffmeister-Polya type in Case 5.

proximately 60 per cent of reported cases when the Polya type of operations are performed for duodenal ulcer and less frequently still when the Billroth I type of resection is performed. In other words, in discussing any problem concerning peptic ulcer, careful differentiation should be made as to whether the ulcerating lesion is in the duodenum or stomach, or both.

The most interesting part of studies of gastric acidity subsequent to various types of operations for duodenal ulcer has seemed to me to be

that it is frequently difficult to tell in the preoperative study of the patient and of his nervous or gastrointestinal habitus, or in study of his gastric acidity, what his clinical response as regards relief of symptoms or changes in gastric acidity will be following any type of operation. For although a greater reduction of gastric acidity will occur and a greater number of patients will obtain relative achlorhydria after partial gastrectomy of the Polya type, marked reductions in gastric acidity, even to the point of relative achlorhydria, not infrequently will occur following gastroenterostomy. An enteroanastomosis made between the loops of the jejunum used in performing the gastroenterostomy or the Polya anastomosis will prevent some of the duodenal, pancreatic, and jejunal secretion entering the stomach, thus interfering in part with the dilution and reduction in gastric acidity (Table V).

TABLE V

PARTIAL LOSS OF THE DILUTION OF GASTRIC ACIDITY WHEN ANTERIOR GASTROENTEROSTOMY WITH ENTEROANASTOMOSIS IS PERFORMED FOR DUODENAL ULCER

CASE	AGE, YEARS, AND SEX	DURATION OF SYMPTOMS	CHARACTER OF ULCER	ACIDITY			
				PREOPERATIVE		POSTOPERATIVE	
				TOTAL	FREE HCl	TOTAL	FREE HCl
1	33 M	15 months	Subacute perforating	50	36	28	20
2	52 M	6 months	Subacute perforating	98	90	82	70
3	31 M	12 years	Subacute hemorrhagic perforating	62	46	60	44
4	59 M	3 years	Subacute perforating	90	80	94	84
5	65 M	25 years	Subacute perforating	58	46	74	56
6	35 M	15 years	Hemorrhagic perforating	88	78	84	70
7	56 M	12 years	Subacute perforating	92	84	60	50
8	38 M	25 years	Multiple subacute perforating	60	50	50	38

TISSUE RESISTANCE

Such a discussion of gastric acidity is important, in spite of the fact that gastric acidity plays a secondary part in the formation either of a duodenal or a gastrojejunal ulcer. Tissue resistance or tissue susceptibility to inflammation or ulceration from the hydrochloric acid of gastric secretion is that on which successful surgical treatment of duodenal ulcer depends; for, if tissue is resistant to hydrochloric acid, the patient will obtain an excellent result from the recognized types of surgical procedures, without recurring ulceration; whereas if the tissue is susceptible to recurring ulceration, and if hydrochloric acid of the gastric secretion continues to be in contact with such susceptible tissue, ulceration may recur. Unfortunately, there is no way at present to measure, in vivo, individual intestinal tissue resistance to gastric secretion. Recent work at the Mayo Foundation by Stalker, Bollman, and Mann would seem to throw some light on this factor of tissue

resistance. These observers found that chronic penetrating gastric ulcers could be produced in 98 per cent of dogs by the oral or enteric administration of cinchophen. When the animals were given a bland, alkaline type of diet, frequently administered with alkaline powder similar to that used in the medical treatment of ulcer, in none of the animals which received cinchophen did chronic ulcers develop. Likewise, and of equal importance, was the fact that if gastroenterostomy was performed on animals which received cinchophen, chronic ulceration did not occur. When cinchophen was administered, the stomach divided, and the upper segment and jejunum anastomosed (exclusion type of operation), gastrojejunal ulcers occurred frequently in the upper segment and also in the lower, if enough of the acid-secreting gastric mucosa was included in the lower segment. In these experiments, one has the factor, not only of lower tissue resistance as a result of the cinchophen, but also of the action of gastric secretion on an area of lowered tissue resistance. These are exceedingly important groups of experiments and have, it seems to me, considerable clinical significance. They strengthen the conclusions relative to the beneficial effects of the alkalization of gastric secretion either as a result of the dietary regimen or of dilution and reduction of gastric acidity by gastroenterostomy.

What place, then, has partial gastrectomy in the treatment of duodenal ulcer? Theoretically it would appear that it has a place in the treatment of hemorrhagic duodenal ulcer, principally because it removes the bleeding lesion and is able to assure the patient a maximal degree of reduction of gastric acidity; yet in many cases of bleeding duodenal ulcer, gastroenterostomy suffices to heal the duodenal lesion. It has an important place in the treatment of recurring duodenal ulceration and in gastrojejunal ulceration. The reasons for its usefulness in this group of cases are similar to those for its usefulness in the treatment of bleeding ulcers, namely, that it removes the ulcerating lesions and gives the patient a maximal reduction of gastric acidity; but in addition, partial gastrectomy performed subsequent to previous operations for duodenal ulcer, whether pyloroplasty or gastroenterostomy, is followed by relative achlorhydria in a much higher percentage of cases than when partial gastrectomy is performed as a primary operation for duodenal ulcer. It will have a place in the treatment of the patient who has duodenal ulcer and whose tissue is abnormally susceptible to recurring ulceration from the irritating effects of hydrochloric acid in gastric secretion.

SUMMARY

Interest in partial gastrectomy for duodenal ulcer was stimulated by Finsterer's visit to the surgical clinics of the United States in the 1920's. The incidence of gastrojejunal ulcer following partial gas-

trectomy was reported to have been reduced to 3.1 per cent in one clinic in the United States. In that clinic the incidence of gastrojejunal ulcer was reported to have been 16 per cent following gastroenterostomy, this percentage being calculated on the basis of operations. It has been shown in some countries in Central Europe that by partial gastrectomy the surgeon removed areas of gastritis associated with duodenal ulcer, and Konjetzny reported the almost constant presence of gastritis in such cases. Such an argument favoring partial gastrectomy could not be used in deciding on treatment of a group of patients operated on at the Mayo Clinic, where definite evidence of associated gastritis was present in less than 12.5 per cent of a group of patients on whom partial gastrectomy was performed for duodenal ulcer.[24] The incidence of recurring ulceration following gastroenterostomy at the Mayo Clinic is 3.2 per cent,[2] in contrast to the greater incidence of recurring ulceration reported from the German surgical clinics and from one of the clinics in this country where partial gastrectomy for duodenal ulcer is advocated. This leads to the opinion that there is marked difference in the geomedical factors relating to types of lesions and their response to similar operative procedures. Quoting from Schittenhelm, the Munich internist: "Gastric and biliary disorders likewise present distinct regional differences—the part played by racial factors in these differences is as yet unknown to science." The operations of partial gastrectomy, gastroenterostomy, and pyloroplasty all serve to reduce gastric acidity; the greatest reduction occurs after the Polya type of operation, although not infrequently relative achlorhydria is obtained when gastroenterostomy is performed. It has been reported in one clinic in the United States that relative achlorhydria was not obtained in approximately 43 per cent of a group of 108 patients on whom extensive partial gastrectomy had been performed for duodenal ulcer, and nine patients developed gastrojejunal ulcer, an incidence of 8.3 per cent.

Tissue resistance and tissue susceptibility to hydrochloric acid, and their measurement, are the factors on which successful treatment of duodenal ulcer depends regardless of the surgical procedure employed, for, if tissue resistance to hydrochloric acid is satisfactory, ulceration will not recur, whereas, when tissues are susceptible to hydrochloric acid of the gastric secretion, ulcer may recur, if free hydrochloric acid persists in sufficient degree, regardless of the surgical procedure employed. Recent work at the Mayo Foundation by Stalker, Bollman, and Mann bears a relation to the factor of tissue resistance in formation of ulcer. Gastric resection has a place in the treatment of certain of the hemorrhagic duodenal ulcers as well as in the treatment of recurring duodenal ulcer and of gastrojejunal ulceration; it also is applicable in treatment of patients whose tissue has lowered resistance to the hydrochloric acid in gastric secretion.

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ADENOMYOMA OF THE INGUINAL REGION

Report of Three Cases

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THE literature which has accumulated on aberrant endometrium-like tissue is evidence of the interest which this subject has aroused and of the attention it has been given by gynecologists and pathologists. It is certain that there is no subject in the realm of gynecology which has led to more controversy, and it is probably equally true that no other subject related to gynecology presents a more fascinating clinical and pathologic picture. Unless the clinician, surgeon, or gynecologist is familiar with the manifestations of ectopic endometrium-like tissue and the situations in which it is not infrequently found, he will in all probability fail to detect some lesions which should be easily diagnosed.

Rokitansky, Babes, Breus, and Diesterweg are said to have been the first to recognize epithelial cysts in myomas of the uterus. In 1896, von Recklinghausen first used the terms adenomyoma and cystadenomyoma to describe uterine and tubal swellings which he thought were derived from the wolffian duct. Sampson is usually given the credit for the introduction of the term endometriosis although it is said by some to have first been used by de Joselin de Jong, and some say that the two men introduced the term independently and simultaneously. For blood cysts of the ovary in which endometrium-like tissue can be demonstrated, Lockyer[23] said that Blair-Bell introduced the "convenient but not strictly correct nomenclature of endometrioma," a term which is currently used to designate similar lesions in any situation. These three terms, adenomyoma, endometriosis, endometrioma, are the ones most frequently employed to describe adenomatous lesions among women, the morphologic and functional manifestations of which are similar to those of the endometrium. The terms apparently are used synonymously but each has its adherents and its critics, and no term is considered ideal. When and if the etiology of this condition is definitely established, an appropriate name can be given to it.

In May, 1896 Cullen[6] described the first case of adenomyoma of the round ligament, a lesion previously unknown. His patient was a woman, aged thirty-seven years, who complained of swelling of the right inguinal region which had been present for eight years. It was severely painful, especially during the menstrual period and after exertion.

Received for publication, May 15, 1937.
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Nineteen months after the removal of the adenomyomatous mass, the patient returned with a similar one on the opposite side. This, too, was removed surgically. Each mass was attached to the round ligament and scattered throughout each mass were islands of glands lined with one layer of cylindrical epithelium. The glands could not be distinguished from uterine glands and the stroma was composed almost entirely of nonstriated muscle fibers.

Cullen[7] wrote in 1898 that 3 similar cases had been reported since the description and publication of his first case in 1896, and in 1908[9] he said that cases had been reported by Pfannenstiel, Blumer, Bluhm, Meyer, Aschoff, and others. Of the 26 cases of tumor of the round

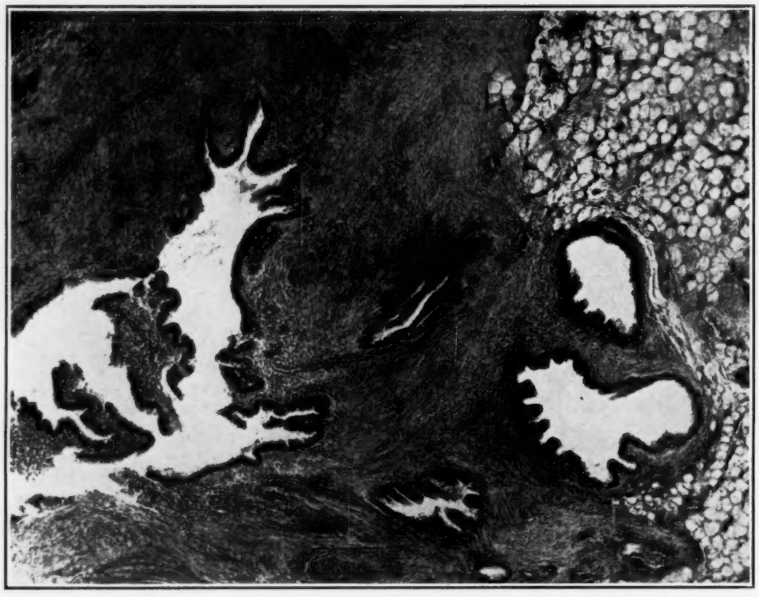

Fig. 1.—Section of tumor found in Case 1; the endometrial glands are typical and the stroma is abundant; adipose tissue is present on the right side (x55).

ligament which he collected in 1903, Emanuel found several adenomyomas, and to this list he added 4 cases of his own. In reviewing tumors of the round ligament in 1914, Taussig collected 135 cases; in 30, or 22 per cent, of these cases the tumor was an adenomyoma. He commented that "the most striking fact in the pathology of round ligament tumors is the comparative frequency of adenomyoma"; these tumors were four times as frequent at this site as they were in 1,283 cases of myoma of the uterus collected by Cullen. Polster reported that in the literature prior to 1926 he could find but 34 cases of adenomyoma of the round ligament, but this figure, although quoted by most writers on this subject, is undoubtedly too low. Judd and Foulds listed three cases of adenomyoma of the groin in their series of 494 cases of adenomyoma. Harbitz said that R. Meyer had not observed

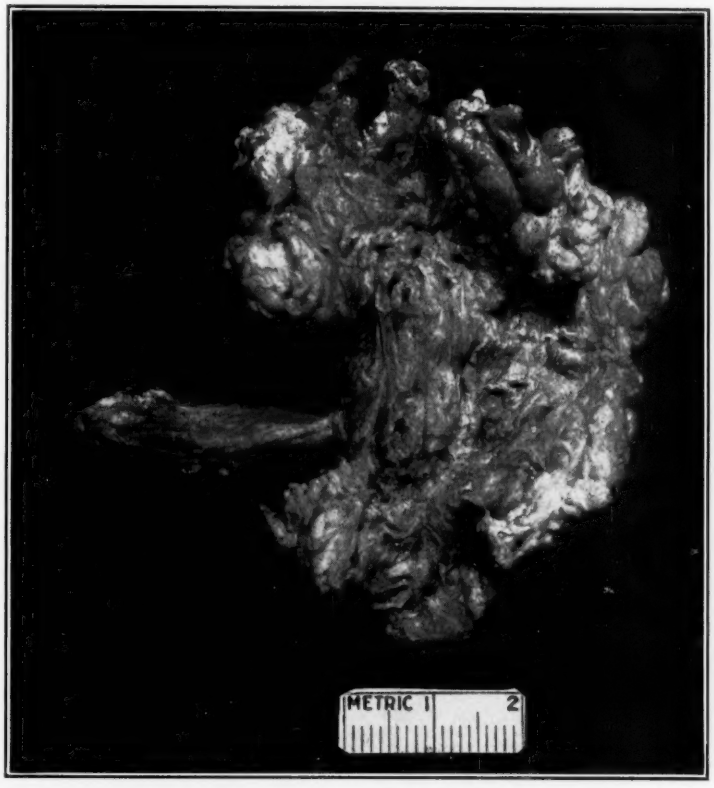

Fig. 2.—Tumor found in Case 2; round ligament is attached to the left side of the mass; tags of fat and fibrous septa are well illustrated.

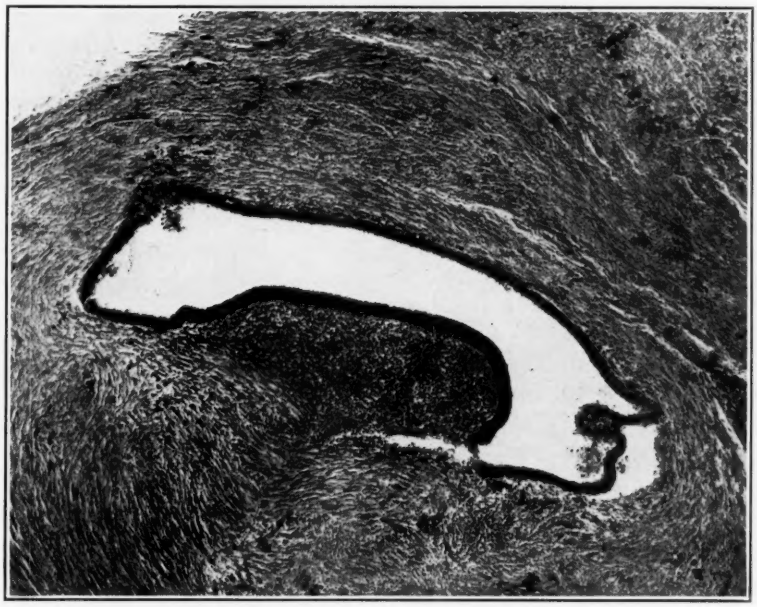

Fig. 3.—Section of tumor found in Case 2; a large gland and stroma cells may be seen at the lower border; the epithelium adjacent to the stroma cells is much taller than that resting directly on the connective tissue or smooth muscle fibers (x80).

more than 3 cases of so-called inguinal endometriosis of his own. In the 159 cases observed by Smith, the tumor was localized in the round ligament in only 1 case. Nielsen said that 60 to 70 cases of adenomyoma of the round ligament have been reported.

Mahle and MacCarty have reported 2 cases of adenomyoma of the groin from the Mayo Clinic and Lemon and Mahle reported an additional case. I wish to report the following cases; in all of these cases there was an inguinal tumor, and in 2 of them there was definite involvement of the round ligament.

REPORT OF CASES

CASE 1.—A married woman, aged thirty-five years, came to the clinic because of a lump in the breast, and a swelling in the right inguinal region, which had been present for eight years. The inguinal tumor was the size of an egg. It was firm and movable but was not reducible. It was situated over the external inguinal ring. Menses were regular and without pain.

At operation the tumor was found to be situated very close to the spine of the os pubis and, while it was not definitely attached to the round ligament, it was thought by the surgeon to be a cyst of the round ligament. It was completely removed.

The mass was firm in consistence although surrounded by adipose tissue. It contained much fibrous tissue and grayish bands traversed it. It measured 3 by 1.5 by 1.5 cm. The tumor of the breast unfortunately proved to be an adenocarcinoma, grade 4, and the patient died a little more than two years following the radical mastectomy.

Microscopic examination of the inguinal tumor (Fig. 1) revealed the typical picture of adenomyoma.

CASE 2.—A married woman, aged forty-four years, who was the mother of two living children, complained of a lump in the right inguinal region. Eighteen years before her registration at the clinic, a right herniorrhaphy had been performed. The incision had drained for four months but the character of the drainage was not stated. Menses had always been regular.

Soreness and pain had been present in the right inguinal region for six months, and four months before she came to the clinic she had noticed the lump. The symptoms had been more pronounced during menstruation.

A firm, movable, tender nodule was palpable just below the old herniorrhaphy scar over the spine of the pubis. Although the patient said that she had had a left inguinal hernia, this could not be demonstrated.

At operation the mass was found to be connected with the terminal portion of the round ligament; it was removed together with a portion of the ligament. There were bilateral indirect inguinal hernias. These were repaired.

The tumor measured 5 by 4 by 2.5 cm., and 2.5 cm. of the round ligament was attached to it. The tumor was firm in consistence and completely covered by fatty tissue. The cut surface was dark brown in color and was reticulated. The trabeculae were grayish in color and between them there were many small cysts filled with a dark fluid (Fig. 2).

The microscopic appearance was that of an adenomyoma (Fig. 3).

CASE 3.—A married woman, aged thirty-nine years, had undergone an appendectomy seventeen years before she came to the clinic. This had been followed by phlebitis in the right thigh. Two years prior to her registration at the clinic she

had had a postpartum infection following the delivery of a stillborn child. Menses had been regular and the interval between the menstrual periods had been twenty-eight days.

The patient complained of a pain over the right lower quadrant of the abdomen following each menstrual period; this symptom had first been noted just after the

Fig. 4.—Tumor found in Case 3; round ligament is attached to upper part of the mass; tags of fat, fibrous septa, and even small cysts are visible.

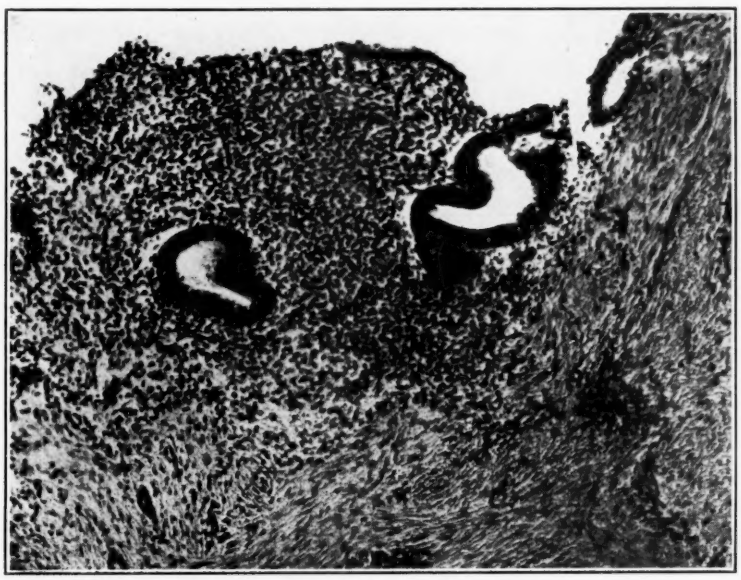

Fig. 5.—Section of tumor found in Case 3; endometrial glands are surrounded by a great number of stroma cells (x105).

delivery of the stillborn child. The pain had been dull and aching in character; it never had been very severe, but it often had persisted for ten or fifteen days after the menstrual period. At times there had been a real sharp pain over the abdomen and the pain occasionally had extended into the right hip and thigh.

Physical examination revealed a healthy appearing woman. There was a healed scar over McBurney's point and tenderness was present over the right lower abdominal quadrant. In the lower part of the right inguinal region there was a firm, tender, fairly well fixed, irreducible mass which measured 3 by 4 cm. On further questioning the patient said this lump had never been reducible, did not increase in size on coughing or straining, and the pain was not made worse when she stood up. The pelvic outlet was relaxed; the anterior lip of the uterine cervix was eroded; the uterus was in the anterior position and freely movable. No adnexal masses were palpated.

Operation was performed by C. W. Mayo. He noted that the mass was hard and scarred as though there had been inflammation in it. The mass, with a portion of the round ligament, was excised and the wound was closed as it is in a hernial repair.

The tumor measured 6 by 4 by 3 cm.; 2.5 cm. of round ligament was attached to it. The mass was firm in consistency and covered by tags of fat. On cross-section (Fig. 4) it was a dark mahogany color except for the grayish fibrous bands which traversed it. There were innumerable small cysts which, when ruptured, exuded a thin, dark, syrupy serum.

Microscopic examination (Fig. 5) confirmed the diagnosis of adenomyoma.

COMMENT

Adenomyomas may occur at any point in the round ligament from its uterine attachment to its termination in the labium majus. Lockyer[22] was of the opinion that they are three times as common in the extraperitoneal portion of the ligament as they are in the intraperitoneal portion, and Cullen[10] said that they are usually found near the external inguinal ring. The intraabdominal tumors cause no characteristic symptoms or signs and the diagnosis of adenomyoma in this situation can rarely be made clinically.

The frequency with which hernia is associated with inguinal adenomyoma is striking. In 1916 Cullen reported a case in which an adenomyoma of the round ligament was associated with incarcerated omentum in an inguinal hernia. He said that to the best of his knowledge it was the first case of that nature reported, and I have found none which antedates Cullen's. Of 8 cases of inguinal endometriosis which Harbitz reported, inguinal hernia was present in 3, femoral hernia was present in 1, and in 1 there was a funnel-shaped distention of peritoneum. Christopher, Palmer, Sampson[33] and others have reported cases in which inguinal endometriosis was associated with hernia. Bilateral hernias were present in Case 2 in the present report.

The diagnosis of a typical adenomyoma of the inguinal region should offer no difficulty. The presence of a more or less fixed, irreducible swelling in a woman in the childbearing age, which is more prominent and more painful during each menstrual period, or is associated with discomfort which is more pronounced following the menstrual period,

should lead one to suspect the true nature of the tumor. Occasionally, the mass will have been present for many years. In the case reported by Blumer, the patient had noticed the mass twenty-three years before she consulted a physician, and in the case reported by Christopher the patient had endured pain for more than fifteen years. One of the patients in the present series of cases had not experienced any pain which was referable to the tumor, and in one case pain had been present for only six months and the presence of the tumor had been noticed only four months before the patient came to the clinic. In one of the cases reported by Palmer[28] the patient complained of an "abscess" of the vulva which had been discharging for two years and which had caused throbbing pain during menstruation. In the case reported by Shaw, the inguinal mass had been mistaken for a broken-down lymph node and had been incised. A sinus had developed and blood had been discharged at each menstrual period.

As far as I am aware, this sympathetic relationship to menstruation produces the only pathognomonic signs and symptoms, although the presence of adenomyoma might be strongly suspected when an inguinal mass exists concomitantly with pelvic adenomyoma. It was pointed out by Beck that the symptoms produced by herniation of an ovary into the canal of Nuck, which first was recognized by Soranus, of Ephesus, might simulate those of inguinal adenomyoma. If inguinal adenomyoma has remained asymptomatic, the diagnosis will probably be made only by the pathologist.

It is to be noted that the round ligaments were involved in the first case reported by Cullen. In reporting a case in 1898, Blumer said that he could find no attachment of the tumor to the round ligament but, he wrote: "the histological structures and situation almost preclude its origin from anything but the round ligament." Harbitz recently said that the finding of smooth muscle fibers in endometrium-like tissue in the inguinal region is usually taken as an indication of connection with the round ligament. In two of the cases reported in the present paper the tumor was attached to the round ligament but in the third case a definite connection could not be demonstrated.

Inguinal adenomyomas are usually of small size; they rarely measure more than 5 to 6 cm. in diameter. At operation the surgeon may be impressed with the inflammatory reaction around the tumor. There is an abundance of adipose tissue surrounding each tumor and a portion of round ligament may be attached to the tumor. When the tumor is sectioned, it is found to be dense and tough and its substance is traversed by a network of interlacing bands of fibers, which are grayish in color and glistening in the fresh specimen. Interspersed between these bands of fibers are small chocolate-colored vesicles which, when ruptured, release a dark, syrupy fluid. The largest cyst in any of these cases was 8 mm. in diameter, but most of the cysts measured about 1 mm.

On microscopic examination the tumor is found to be composed of fibers of connective tissue and smooth muscle which have no definite arrangement. Van Gieson's method of staining revealed a predominance of connective tissue in two specimens, while in a third specimen smooth muscle fibers predominated. Several areas of adipose tissue were scattered throughout the tumor and blood vessels were very numerous. Glands of various sizes and shapes were found in all parts of the tumor. These glands, which were called miniature uterine cavities by Cullen, were lined by columnar epithelium and most of them were surrounded by a stroma similar to that of the uterine mucosa, but a few rested directly on the muscle or connective tissue fibers. Large phagocytic cells containing blood pigment were present in abundance.

Robert Meyer, according to Graves, expressed his belief that the appearance of smooth muscle fibers, except in rare embryonic tumors, is due to irritating hyperplasia produced in the surrounding tissues. Graves subscribed to this teaching and said that the term adenomyoma is, therefore, a misnomer. The paucity of smooth muscle fibers in the specimens obtained in the present series of cases might lend some support to this theory.

Cullen[8] was the first to draw attention to the clinical analogy between adenomyoma and the menstrual endometrium, and in 1908 he reported a case in which there was a tubal pregnancy in the left fallopian tube and diffuse uterine adenomyoma in the right horn of the uterus. The stroma cells around the adenomyomatous region had undergone the typical reaction of pregnancy. Palmer reported a case in which he found a ruptured tubal pregnancy and a nodule in the mons veneris on the right side, which extended upward into the inguinal canal. The microscopic picture of adenomyoma was altered by the tubal pregnancy.

The origin of inguinal adenomyoma is as debatable today as it was when first described by Cullen, and many theories have been advanced. Cullen has always believed that these tumors are derived from misplaced portions of Müller's duct. As evidence of this he drew attention to the similarity of the glands in adenomyoma to the normal uterine glands and to the fact that the glands are surrounded by stroma like that found in normal uterine mucosa. The sympathetic relationship of the misplaced glands with the menstrual periods, or their response to the hormones which govern the activity of the uterine endometrium, is well known and would indicate a similar origin of them and the uterine glands. The occurrence of a pregnancy in adenomyoma has even been described.[13] As late as 1925, Cullen[11] again emphasized his conviction that typical adenomyomas originate from the müllerian duct and said that adenomyoma of the round ligament must be considered as an embryonic inclusion since it would be impossible to explain it

by transplantation. Ewing was of the opinion that "it would be wise to assume that in all probability they are of congenital and not of the acquired type."

Von Recklinghausen said that adenomyomas are of wolffian origin, as previously mentioned. This opinion was based on the supposed close analogy between elements of the wolffian duct and the glandular structures of the tumors. This theory has gradually lost ground and today it has few supporters.

The implantation theory of the origin of aberrant endometrium-like tissue, which has created tremendous interest and debate, was advanced by Sampson[32] in 1921 in an article entitled "Perforating Hemorrhagic (Chocolate) Cysts of the Ovary." According to this view, fragments of the uterine mucosa migrate through the fallopian tubes during menstruation and lodge on the ovary. There they are nurtured and chocolate cysts eventually are formed. With the increase in tension due to the accumulation of blood in the cyst, perforation may occur and fresh implants are scattered over the pelvic peritoneum and adjacent structures with resulting inflammation and the formation of new cysts. Sampson[33] said that there may be a direct extension along the round ligament, from these implants, or from peritoneal endometriosis situated about the internal inguinal ring, or there might be implantations in a hernial sac. Another possibility, which was advanced by Halban and supported by Sampson,[33] is that of metastasis through the lymphatics or veins accompanying the round ligament. Sampson[34] has expressed the belief that fragments of endometrial tissue are occasionally disseminated into the venous circulation during menstruation and he said that metastatic or embolic endometriosis may arise from this source.

The following objections to the implantation theory have been most clearly and lucidly voiced by Novak. He has never seen menstrual blood escaping from the tubal ostia, and in thousands of cases in which operation was performed just after menstruation, blood was not found in the peritoneal cavity, and there was no evidence of peritoneal irritation as is usually produced by blood. Regurgitation is too infrequent to explain a condition as common as aberrant endometrium-like tissue. The action of the cilia of the tubal epithelium is toward the uterus and would probably not allow retrograde transplantation of fragments of endometrium. The viability of cast-off endometrium is highly improbable, and the delicate peritoneum would offer a more inviting field than the dense and avascular albuginea of the ovary.

The serosal theory of the origin of aberrant endometrium-like tissue is associated with the names of Iwanoff and Meyer, the former having shown that ingrowing processes of epithelium derived from the peritoneum may give rise to the cystic spaces found in some fibromyomas, and Meyer having shown that epithelial heterotopy can occur in the

serosa. Novak supported the ectopic differentiation of celomic epithelium as a source of aberrant endometrium. The celomic epithelium of the urogenital folds gives rise to the germinal epithelium of ovary, the follicular epithelium, and the lining of the müllerian ducts. Since tissues derived from the same embryonic mother epithelium are similar, it is "not surprising that either peritoneum or germinal epithelium may at times show endometrial transformation." The endometrium-like tissue which appears in the inguinal region or in the vulva may arise from the remains of the processus vaginalis which has become activated.

The frequency with which adenomyomas are encountered, and their surgical importance, together with the mystery surrounding their origin, warrant a sustained interest in this subject.

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REMOVAL OF THE UPPER JAW
AN HISTORICAL OPERATION

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THE United States was in the throes of a financial crisis in 1893, a crisis which might easily have ended in a panic causing a world-wide catastrophe. It was a question whether or not the country should go off the gold standard, and there were fierce arguments on both sides. It was said openly that Mr. Cleveland was about all that stood between the people and absolute disaster, and his death would be a great calamity. The words were spoken in innocence, but only three persons knew how near these words were to the truth.

Vague rumors were circulated that the President was not as well as he should be, and that he had gone from Washington into sudden retirement to his country house at Gray Gables on Buzzards Bay, Massachusetts. Inquiries were made, and Colonel Lamont, Secretary of War and Cleveland's most intimate friend, telegraphed to Washington: "The President is laid up with rheumatism in his knee and foot, but will be out in a day or two. No occasion for any uneasiness." This statement, however, did not satisfy the press, so Colonel Lamont invited the representatives of the chief newspapers to meet him that he might give full explanation of everything. He asked that they should say nothing until they had seen him and purposely fixed a late hour when the evening editions were already off the press.

The reporters found headquarters at an hotel near the railway station at Buzzard's Bay. At the appointed hour, they walked in a body across the old railway bridge down to Gray Gables, a mile and a half away. Colonel Lamont met them at an old barn, about 200 yards from the house. He greeted the men cordially, and told them it was really very foolish to make such a stir over a matter which was essentially trivial. The President had suffered from an attack of rheumatism to which he was occasionally subject, and had made a prolonged journey on Mr. Benedict's yacht for some dentistry. The President, being very busy, disliked having a dentist over him and consequently had allowed his dental work to become so badly neglected that he finally felt compelled to go on the yacht; there he would be cool and comfortable while the dentist could do a thorough job of fixing his teeth. The newspapermen inquired the name of the dentist, what had to be done, and other minor details to which Lamont replied that they were too trivial to talk about.

Received for publication, June 22, 1937.

The reporters walked back to the hotel arguing briskly. Half of them did not believe what they had been told; the other half were more credulous. They reached an agreement, however, that they would stand together on whatever story they should send out, and then went into conference at the hotel to decide what their story should be. The next day, without a dissenting voice, the newspapers, including the press associations, gave to the country a reassuring version of the

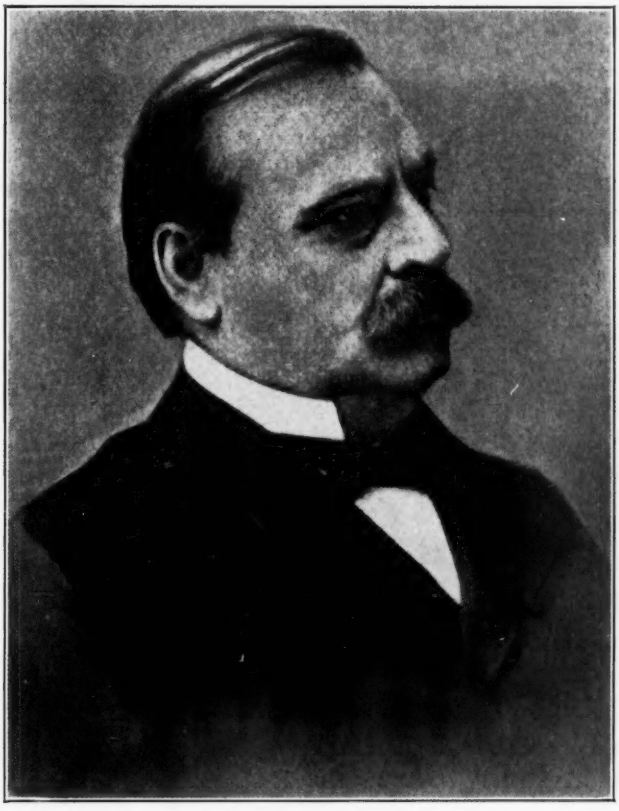

Fig. 1.—Grover Cleveland. (After Nevins Allan: Grover Cleveland, New York, 1932, Dodd, Mead & Company, Inc., p. 304.)

case. At 6 o'clock on Friday evening, June 30, an extra session of Congress was summoned to meet on August 7.

When Congress met in special session on August 7, Mr. Cleveland's message urged the absolute repeal of the Sherman Act without any substitute and without any compromise. On August 11 Mr. Cleveland returned to Gray Gables, and while there he heard that the House had passed the repeal on August 28 by a vote of 239 to 101; on October 30 the repeal was passed by the Senate.

The inner history was revealed many years afterwards by Dr. W. W. Keen, the doyen of American Surgery. Writing in 1917, he says,

"On Sunday, June 18, 1893, Dr. R. M. O'Reilly, the official medical attendant on officers of the government in Washington, examined a rough place on the roof of Mr. Cleveland's mouth. He found an ulcer as large as a quarter of a dollar, extending from the molar teeth to within one-third of an inch of the middle line encroaching slightly on

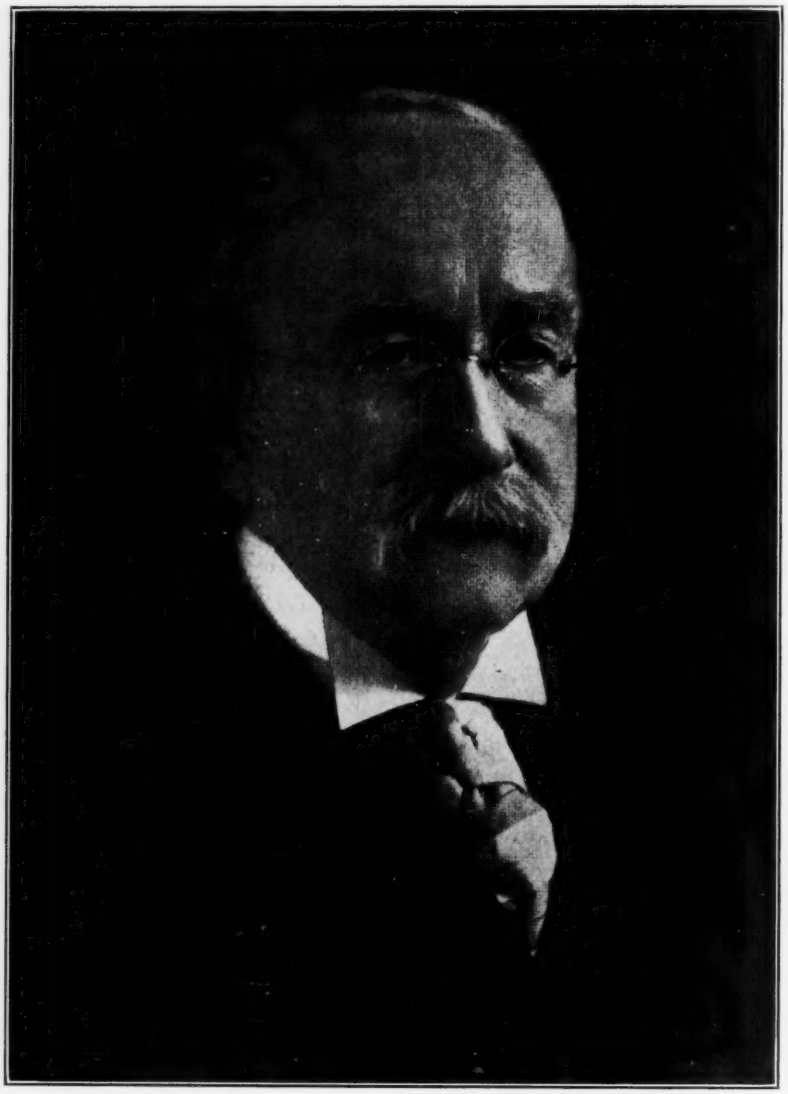

Fig. 2.—William Williams Keen, M.D., Sc.D., Ph.D., LL.D. (From Am. Med., December, 1921.)

the soft palate, and some diseased bone. The pathologist at the army medical museum reported that the tissue sent to him was strongly suggestive of malignancy. Dr. Joseph D. Bryant, an intimate friend and the usual medical attendant of the President, confirmed the diagnosis and recommended immediate removal. Mr. Cleveland consented to an

operation provided that a time and place was chosen where publicity could be avoided, and decided that July 1 was the earliest suitable date for himself. Colonel Lamont was told of the decision and it was agreed that to secure secrecy the operation should be done on the

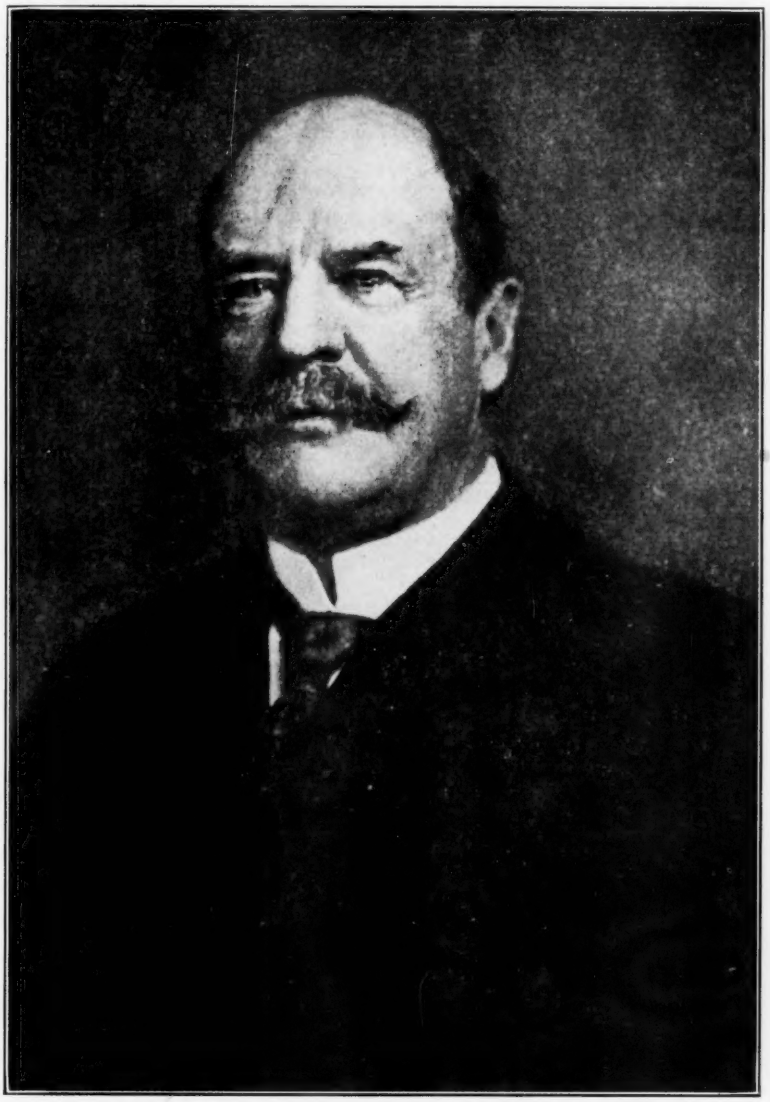

Fig. 3.—Joseph D. Bryant, M.D. (From Surg., Gynec. & Obst., February, 1908.)

'Oneida,' Commodore Benedict's yacht, and that the President should return to Washington on August 7.''

Dr. Keen was called in consultation, and Dr. Bryant met him at a quarter past three on the deck of the Fall River boat which was then deserted as the sailing did not take place until six o'clock. Here without interruption the necessary plans were arranged. The living

rooms on the "Oneida" were prepared and disinfected; an operating table and all the necessary instruments, drugs, dressings, etc., were sent on board. Dr. Ferdinand Hasbrouck, a dentist accustomed to giving nitrous oxide, was asked to assist.

Dr. Keen arrived in New York on June 30, went to Pier A and was taken over to the yacht which was lying at anchor at a considerable distance from the battery. Dr. E. G. Janeway of New York, Dr. O'Reilly, Dr. John F. Erdmann, Dr. Bryant's assistant, and Dr. Hasbrouck had also gone secretly to the yacht. The President, Dr. Bryant, and Secretary Lamont arrived later from Washington and drove openly to Pier A, whence they were taken to the yacht.

On arriving at the yacht the President lighted a cigar and sat talking on deck until nearly midnight. He passed a good night sleeping well without a draught, and before he dressed the next morning, Dr. Janeway made a careful examination of his chest. Nothing was found to be wrong; there was, however, some evidence of arteriosclerosis and his kidneys were believed to be almost normal. Dr. Keen also examined the President and was told that the rough place in his mouth was not there on March 4, but had been first noticed six or eight weeks before the first of July. There were no perceptibly enlarged glands, but Dr. Keen had no doubt that the growth was unquestionably malignant. The patient's mouth was repeatedly cleansed and disinfected in the course of the morning.

The anesthetic caused some anxiety for the President was fifty-six years of age, very corpulent with a short, thick neck, and tired out by four months of exacting labor. The whole matter was considered carefully, and it was decided that Dr. Hasbrouck should give nitrous oxide first, and ether later if necessary.

The operation was performed on July 1 while the yacht was going up the East River at half speed. Commodore Benedict and Secretary Lamont remained on deck while the operation was being performed in the cabin. Dr. Hasbrouck first extracted the two upper left bicuspid teeth under nitrous oxide, and Dr. Bryant then made the necessary incisions in the roof of the mouth also under nitrous oxide. Ether was given by Dr. O'Reilly at 1:14 P.M. while Dr. Janeway kept a close watch upon the patient's pulse and general condition; Dr. Keen and Dr. Erdmann acted as assistants to Dr. Bryant.

The entire left upper jaw was removed from the first bicuspid to just beyond the last molar and close to the middle line. The floor of the orbit was left and a small part of the soft palate was cut away. The antrum was filled with a gelatinous mass which Professor W. W. Welch afterward reported as sarcomatous. The entire operation was done within the mouth without any external incision. The absence of an external scar, or of any displacement of the eye together with the

preservation of the normal voice aided greatly in keeping the operation a secret. The bleeding was not severe, only one artery had to be tied, and the patient did not lose more than six ounces of blood. The operation was finished by 1:55 P.M., and an hour later a hypodermic of one-sixth grain of morphine was given which did not need to be repeated. The patient made a good recovery. He was up and about on July 3, and on July 5 he walked from the launch to his home at Gray Gables with little apparent effort. A small secondary operation was performed on July 17 when the galvanocautery was used to remove a small portion of suspicious looking tissue; a prosthetic appliance was supplied by the dentist, and the patient was able to go about his ordinary duties. Mr. Cleveland died June 24, 1908, fifteen years after the operation, without any recurrence of the growth.*

*The information is taken from "The Surgical Operations on President Cleveland in 1893" by William W. Keen, M.D., LL.D., Philadelphia, Pa. George W. Jacobs and Co., 1917, pp. 52.

Editorials

Peptic Ulceration

ULCERATION of the stomach and duodenum, although relatively easily treated by conservative measures, still represents a therapeutic problem, because of the great tendency toward recurrence. As is well known, seasonal recurrence of peptic ulceration is the rule, and many patients have been repeatedly cured of a gastroduodenal ulceration only to have the ulcerative process return at some subsequent date.

Many theories concerning the causation of chronic ulceration of the stomach and duodenum have been suggested, and in all probability there are several factors which are responsible in individual cases. Because gastroduodenal ulcers usually recur following a satisfactory healing of the ulcerative process, the likelihood of a constitutional predisposition of the ulcer must be considered. At the present time it cannot be definitely stated what the underlying abnormality is which is responsible for the predisposition to ulceration. It may be a sympathico-adrenal hyperirritability, as suggested by Crile; a vagotonia, as suggested by Bergmann; or a peculiar arrangement of the capillary mucosa of the stomach with the formation of large plexuses in the submucosa, as demonstrated by Duschl, Mueller, and Heimberger. A realization and acceptance of the constitutional predisposition to peptic ulcer in ulcer patients is important from the standpoint of therapeusis, because obviously recurrence of the ulceration is likely when the patient is subjected to the same conditions. This probably accounts for the fact that gastroduodenal ulcers frequently recur under the present methods of therapeutic management and, unless the therapy is changed, recurrence of the gastroduodenal ulcer will continue to be the rule rather than the exception.

If one accepts the constitutional predisposition to ulceration in ulcer patients, how can one account for the healing of an ulcer in such an individual? Undoubtedly the ulcer diathesis alone is not sufficient to produce a mucosal ulceration of the stomach and duodenum. There must be in addition some other factors which are "precipitating" ones. Of the precipitating factors, gastric hyperacidity, gastric trauma, and pylorospasm are the most important. Of these three, hyperacidity occupies the first rôle, because as long as these ulcers have been treated, whether conservatively or radically, healing has followed the use of measures which tend to reduce the acidity of the stomach and

duodenum. The control of the precipitating factors, namely, hyperacidity, gastric trauma, and pylorospasm, in an individual with an ulcer diathesis will usually bring about a healing of the ulcerative process. As a matter of fact, only exceptionally is it difficult to secure healing of a peptic ulcer if conservative measures are employed. Too frequently, however, the physician's and patient's attentions are focused on the presenting symptom, the ulcer, and after the ulcer has healed the patient is allowed to revert to his former method of living, which again permits the precipitating etiologic factors to come into play and result in a recurrence of the ulcer. In such instances it is probably just as illogical to direct one's entire attention toward the healing of the ulcer, which is merely a symptom of an underlying constitutional abnormality, as it is to direct one's attention toward the control of the fever in a systemic condition which is associated with pyrexia.

If the conception that the ulcer patient has a constitutional predisposition to gastroduodenal ulceration is correct, it becomes necessary for the therapy of the patient to extend probably throughout his lifetime; and as little can be done as regards the predisposing factors, the treatment should consist of controlling the precipitating factors. This does not mean that a patient is forced to remain on a strict dietary regimen throughout the rest of his life, because, whereas a strict dietary plan may be essential in the presence of acute ulceration, it is certainly not necessary after the ulcer has healed. In such instances the avoidance of those factors which predispose to the precipitating causes is usually all that is necessary for the patient to remain well. As hyperacidity is increased by smoking and the ingestion of alcoholic beverages, it is imperative that the patient with an ulcer diathesis abstain totally from tobacco and alcohol. Because food is an excellent neutralizing agent, such individuals should eat frequently, four to five times a day, for the rest of their lives, never overeating at any time. As gastric trauma is a precipitating factor, the avoidance of rough foods is essential. The observance of such a conservative therapy, namely, the alteration of the life of a patient with an ulcer diathesis, will probably result in a prevention of a recurrence of the ulcer by obviating the precipitating factors in an individual with a constitutional predisposition.

If the above conception of gastroduodenal ulceration is correct, it is improbable that surgical measures for the cure of ulceration per se will be of any value. It is the definite opinion of the author that surgery of peptic ulceration should consist largely, if not entirely, of the treatment of complications and not of the ulceration itself. It is illogical to assume that predisposition to the ulcerative process can be altered by a surgical procedure.

Because of the definite susceptibility of certain portions of the gastrointestinal tract to the peptic digestive activity to the acid gastric chyme, as is demonstrated by the predilection sites of ulceration in the gastroenteric system, it is important that a surgeon avoid those operations which will subject an abnormally susceptible portion of the intestine to the acid gastric chyme. Reference is made particularly to the promiscuous performance of gastroenterostomy, because, as can be shown experimentally and clinically, the susceptibility to peptic digestion increases with the aboral distance from the pylorus. In other words, the jejunal mucosa is more susceptible to the digestive action of the acid gastric chyme than is the duodenal mucosa, and the ileal mucosa is more susceptible than either of them.

Although gastrojejunostomy is the most frequently employed operation in the treatment of gastroduodenal ulceration today, it is in many cases a dangerous procedure because of the likelihood of an ulcer occurring in the jejunal mucosa opposite the gastroenteric stoma. One cannot deny that a gastroenterostomy frequently gives splendid results, and it is the operation of choice in those cases of pyloric occlusion in which, as a result of the long-standing gastric stasis, there has occurred an atrophic gastritis with a hypochlorhydria or an achlorhydria. The emptying of the gastric chyme into the jejunum in such an instance because of the low or absent free hydrochloric acid does not result in an ulceration of the highly susceptible jejunal mucosa. In a patient, however, with a hyperacidity a similar operative procedure is likely to cause a jejunal ulceration. It is for this reason that careful preoperative gastric analyses should be made in all cases of peptic ulceration in which an operative procedure is considered.

Of greatest importance in the treatment of gastroduodenal ulceration is the realization by the physician and the patient that the lesion limited to the stomach or the duodenum is only a part of an underlying constitutional predisposition, and that in order that a satisfactory result can be obtained, it is necessary that the patient change his mode of living in such a way that the precipitating factors which are responsible for the ulceration are obviated. When such plan of treatment is used, undoubtedly the high incidence of recurrence of ulceration can be decreased. In the surgical treatment of complications of peptic ulcer, it is important to avoid those procedures which will subject an abnormally susceptible portion of the intestinal tract to the acid gastric chyme. In a patient with a hyperacidity a gastrojejunostomy should not be done, but preferably a pyloroplasty or gastroduodenostomy, both of which permit the emptying of the acid gastric chyme into a portion of the intestinal tract accustomed to receiving it, i.e., the duodenum. In perforations of a peptic ulcer, simple closure of an ulcer without the performance of a gastroenterostomy should be

done. In cases in which malignant change in the ulcer is suspected, such as calloused ulcer on the lesser curvature which does not respond to conservative therapy and all ulcers on the greater curvature, because many of these are primarily malignant, a subtotal gastrectomy should be performed.

—*Alton Ochsner.*

Infections of the "Dangerous Area" of the Face

THE majority of infections of the so-called "dangerous area" of the face are of minor significance. In a small group, fortunately a very small group, the infection is fulminating in character and the fatal outcome is almost predetermined. Between these two extremes, however, lies another group of cases in which an originally insignificant lesion by unwise methods of management and by meddlesome interference is converted into a condition which is always dangerous and which is very frequently fatal. There is no more tragic group of cases in surgery because there is no group of cases in which the lethal issue is so utterly unnecessary.

Any lesion in the "dangerous area" of the face has the gravest potentialities for harm. The surgeon who recognizes these potentialities and who impresses them upon his patients is no alarmist but a truly conservative practitioner. Yet all too often he fails to utter the warning. The regrettable truth is that he does not himself recognize the risk of infection in this area because he does not know, or does not take the trouble to recall, the anatomic and physiologic circumstances which prevail.

The skin about the mouth and lips is thickly interwoven with underlying muscle fibers, blood vessels, and lymphatics, which are here embedded in an unusually small amount of connective tissue. The distribution of the venous supply provides what amounts to a direct connection between the veins of the lip and the cavernous sinus in the anterior of the cranium; and the veins, furthermore, are lacking in valves and possess relatively rigid walls. The stage is set anatomically for a rapid spread of infection, and on the physiologic side the picture is equally unpropitious. The first principle of the limitation of infection is the limitation of motion in the affected area, and the environment here militates against it. Eating, drinking, smiling, laughing, talking, crying, even thought and emotion, result in changes of facial expression. Motion may be expressly prohibited, but the prohibition is almost impossible to obey absolutely, and the delirious and comatose states which ensue early in the disease are other factors against its fulfillment.

To these inevitable and unpreventable circumstances is added an external factor, trauma, which, although entirely preventable, is present in at least 90 per cent—some authorities say 100 per cent—of all

serious cases. It is usually introduced by the patient, but in too large a number of cases it is increased by the physician, if the initial responsibility be not actually his. His instinct, like the patient's, is to do something about it. Once manipulation is undertaken, a superficial lesion promptly becomes potentially if not actually serious. Rarely is pus obtained in any amount. Usually blood or bloody serum is forced into the surrounding tissues, increasing the tension of the parts and furnishing an excellent culture medium for the bacteria already present. The wall of leucocytes, upon the integrity of which the limitation of the infection depends, is broken down. The connective tissue about the mouth accomodates itself very poorly to infection, which is carried onward without obstruction by the rich venous supply, the process being accelerated by the constant motion of the affected parts and the absence of valves in the facial vein. One step rapidly succeeds another. Thrombophlebitis passes over into a thrombosis of the vital centers. Unilateral disease tends to become bilateral early because of the close communication between the cavernous sinuses by interlocking venous channels. The final stages of meningitis and septicemia are not long delayed, and metastatic foci develop elsewhere in the body if the patient should live long enough; he usually does not.

The dramatic progression of pathologic events is paralleled clinically. Beginning as an insignificant carbuncle, furuncle, or boil, with slight or absent local symptoms, the initial lesion rapidly exhibits marked swelling, reddening, induration, and edema of the parts. The patient suffers excruciating pain. Chills occur, the fever mounts to 107° or 108° F., and higher, and the pulse rate is correspondingly accelerated. The swelling becomes more extensive, involving the eyelid, closing the eye, producing exophthalmos, and causing the characteristic "butterfly" discoloration of the tissues of the forehead. The patient, who is extremely toxic, is comatose or wildly delirious. The course of the whole illness is incredibly swift, and when the stage just described has been reached, the fatal outcome is not long delayed.

Diagnosis offers no problems, but treatment offers many. Most of the therapeutic suggestions may be dismissed without very much consideration. These include local application of various bright-colored antiseptics; cauterization by phenol or the electric cautery, or the injection of carbolic acid; circuminjection of the lesion by the patient's own blood; Bier suction; and the use of Bier's constricting band around the neck. Most of these methods are meddlesome and have inherent in them the element of trauma which must, at all costs, be avoided. More rational is the suggestion that any lesion in this area, immediately on its development, should be splinted with adhesive tape, to secure immobility of the affected area.

The general opinion today in well-informed surgical circles is that the less done locally the better, regardless of the stage of the process.

If the patient keeps his hands off the initial lesion, and if the physician follows suit, the majority of such infections will die a-borning. The local application of alcohol or some similar drying agent may furnish to both parties the mental relief of some sort of action, but manipulation must be strictly avoided. Both for the initial lesion and for the lesion in more advanced stages, x-ray therapy seems to be developing a clear field of usefulness. Many cases are on record in which this method has apparently aborted mild infections and controlled more severe ones, the favorable action, according to a recent editorial in the *Journal of the American Medical Association* (**109**: 278-279, 1937), being due to the breaking down of certain radiosensitive cells and the consequent liberation of powerful antitoxic substances.

Rest in bed, preferably in the hospital, is obligatory for any but the simplest case. Speech is strictly forbidden, as is any other action requiring motion of the lips. Only liquid nourishment is given, and it is usually administered by nasal tube. Opiates and sedatives are employed as necessary. Local measures are limited to the use of compresses, which must be small and light and which must be kept constantly moist, preferably by the use of a medicine dropper. Tap water, or some saline solution, is entirely satisfactory, and it is essential that the temperature be moderate; the patient's pain is often so severe that he may be burned without comprehending what is happening. Incision is reserved strictly for the time when localization shall have occurred. The routine use of these precautions often suggests to the patient much ado about nothing, but the physician is entirely justified in insisting upon them. For one thing, when they are employed early enough, they are practically always effective. For another, the end results of this condition are serious enough to warrant any amount of care in aborting them.

Even when thrombophlebitis has frankly occurred, the general opinion is that conservative measures are still best. In spite of the successful cases on record, most surgeons of experience regard ligation of the angular vein as of dubious value. The anatomic circumstances are against success because of the rich venous anastomosis in this area. If ligation is done late, infection is likely to have extended beyond the point at which the ligature is applied, while there is the additional danger of loosening the clot by the surgical manipulation, however carefully it is done.

Few patients survive when the infection has reached the cavernous sinus, and most surgeons agree that thrombosis in this region can scarcely be considered a surgical complication, if for no other reason than that meningitis develops so promptly after it has occurred. It has been estimated that while only 7 per cent of such patients recover without surgery, less than 7 per cent recover with it.[1] The management of the terminal septicemia and meningitis offers no problems which are not presented at other times, although the very occasional case in which

the intravenous use of staphylolysate has been successful suggests a further trial of this agent. Prontosil has not been used for a sufficiently long period of time to permit accurate generalizations concerning it.

Obviously, infections of the "dangerous area" of the face, although infrequent in their serious manifestations, are always potentially highly dangerous and should be treated with the greatest fear and respect, no matter how early they are seen and no matter how trifling they may seem. With the proper prophylaxis, and particularly with the strict elimination of any sort of trauma, the majority will terminate as innocuously as they began. But their harmlessness is dependent upon the self-restraint of the patient who exhibits the lesion and the physician who treats it. In this condition procrastination for once reaps shining rewards and zeal and promptness are attended by fearful consequences. Surgical nihilism is a plan that is generally distasteful to patient and physician alike, but this is one disease in which it is the only type of therapy not attended by a tragic death rate. Walton Martin, who wrote the classical paper on this subject,[2] said almost the last word upon it when he pointed out that the application of any other method will "during a long lifetime lead to an astonishing mortality."

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—Urban Maes, M.D.
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Recent Advances in Surgery

CONDUCTED BY ALFRED BLALOCK, M.D.

HYPOGLYCEMIA

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ONLY a few years have elapsed since Wilder[1] and his coworkers confirmed Seale Harris'[2] conception of a clinical entity of hyperinsulinism. Their demonstration of the presence of insulin in the metastases of a tumor arising in the pancreas, the clinical picture of which resembled in every respect the syndrome of overdosage from insulin, marked one of the important mileposts in the progress of endocrinology. Shortly after the appearance of this observation, other examples, differing somewhat in type, began to appear, including several reports from this institution.[3] Very rapidly a considerable amount of clinical and experimental data related to the subject has been amassed. So extensive is the literature that a careful detailed review of it would require a monograph of considerable size. Such a study is hardly necessary in view of the fact that already several adequate papers reviewing the earlier literature have appeared. In America, those of Harris[4] and Whipple and Frantz[5] are outstanding. Wauchope[6] in England, Sigwald[7] in France, and Joseph Wilder[8] in Germany have contributed extensive bibliographies. In this review, so far as possible, I shall stress those contributions that have appeared since the last of the above reviews, referring only briefly, wherever necessary, to earlier studies.

It has become more and more apparent that our conception of hypoglycemia must be exactly opposite from that of diabetes mellitus. Those factors at play in the elevation of the level of sugar in the blood can likewise cause the lowering of sugar in the blood. Unfortunately, this mechanism is at the present time poorly understood in many of its aspects, just as is the study of carbohydrate metabolism, with which it is intimately concerned. Harris originally considered hypoglycemia a result of an excessive secretion of insulin into the blood stream, just as diabetes mellitus had been considered the result of a deficient secretion of insulin. Such a conception was only logical. Since the original observations of Minkowski that total removal of the pancreas was associated with glycosuria, attention was almost completely focused on the pancreas. It was soon established that in external pancreatic fistulas this glycosuria did not occur, nor was it present when the entire pancreas was removed

Received for publication, Sept. 24, 1937.

and a small portion of it transplanted. Further evidence of the endocrine nature of this secretion was found when it was noted that there was hyalinization of the islets of Langerhans in occasional patients dying of diabetes mellitus, that these islets did not atrophy when the pancreatic ducts were ligated, and that the beta cells of these islets seemed to be the structures most concerned in the elaboration of this secretion. This conception of the relation of the pancreas to carbohydrate metabolism reached its culmination when Banting and Best were able to produce an active extract that would lower the level of sugar in the blood. Apparently the production of insulin is a unique function of the islets, although other substances have been reported to lower the blood sugar level.[9, 10] It is quite possible that many substances having a hypoglycemic action in the blood stream do so indirectly through their effect on organs intimately concerned in carbohydrate metabolism. Acetylcholine,[11] for example, lowers the blood sugar level either through its action on the vagus or by direct inhibition of glycogenolysis. The hypoglycemic action of insulin is generally constant in a controlled experiment, while the level at which hypoglycemic symptoms occur often varies quite markedly.[12-15]

The association of clinical hypoglycemia with an excessive production of insulin is a rational one and this conception was soon verified by the demonstration of a carcinoma having its origin in the islet tissue with metastases to the liver from which insulin could be extracted.[16] Following this, Roscoe Graham excised the first localized islet-cell adenoma with cure of the hypoglycemic state.[17] Shortly before this, however, Finney had operated upon a patient and no tumor had been found.[18] For the first time we were thus confronted with the fact that hypoglycemia may be present with no apparent lesion in the pancreas, just as diabetes mellitus often has been found present with no morphologic evidence of insulin insufficiency. In order to understand how this may occur, it will be necessary to review briefly the action of some of the other organs in the maintenance of normal blood sugar level.

MAINTENANCE OF BLOOD SUGAR LEVEL

Carbohydrate ingestion does not play as important a part in the maintenance of the level of blood sugar in the normal animal as was once thought. While in prolonged carbohydrate feeding there is an initial rise in blood sugar, this generally returns to normal and remains so.[19, 20] The reverse is true in prolonged fasting, where even an increase in the size and number of the islets has been noted.[21] It must be constantly borne in mind that the blood sugar level will vary in different individuals just as it will vary in the same individual even under basal conditions.

Mollerstrom[22] has recently enlarged upon Forsgrens' conception of the rhythmic functioning of the liver with its alternation in glycogen

production and bile secretion. During glycogen production there is a tendency toward carbohydrate retention in the body with a lowering of blood sugar. The reverse holds true during bile secretion. He finds that this endogenous periodicity varies not only in different individuals but likewise in the same individual.

The exact action of the liver in maintaining homeostasis is still poorly understood. The conception of Soskin and his coworkers[23-27] is interesting. In their study concerning the utilization of carbohydrates in totally depancreatized dogs, they found no evidence of impairment of the ability to oxidize carbohydrates. They were able to obtain normal glucose tolerance curves in animals in which the presence of insulin had been completely excluded, a constant blood sugar level being maintained artificially. They are of the opinion that the normal glucose tolerance curve depends upon the response of the liver to exogenous sugar, the organ decreasing its supply to the blood stream in the presence of such an exogenous influx. The action of insulin is to determine the threshold at which this homeostatic reaction comes into play.

While the exact mechanism employed by the liver in its function is still under discussion, the fact that it plays an important rôle in the maintenance of blood sugar levels has been recognized since the days of Claude Bernard. The studies of Mann and Magath[28, 29] on the effects of complete and partial removal of the liver have been of the greatest importance. Although they have noted that if only 15 per cent of the liver is present there is only slight change in blood sugar levels, reports of the experimental production of hypoglycemia by the action of various toxins upon the liver are common.[30-35]

Of striking importance in the maintenance of normal blood sugar level is the anterior lobe of the hypophysis. The fact that the hypophysis was concerned in some way has been recognized for a long time, and as early as 1912 Cushing reported a hypophyseal tumor associated with hypoglycemia. Because of the fact that the hypophysis is apparently an activator for so many of the endocrine glands and that these glands tend to atrophy both anatomically and functionally when the anterior lobe is removed, pure experiments were difficult to obtain until active extracts of these other glands were available. During the past few years considerable information on this subject has accumulated, especially from the laboratory of Houssay and his coworkers.[36] When the hypophysis is removed, practically all species of animals present a marked fall in blood sugar on fasting as well as an extreme sensitivity toward insulin. This is not only true of the toad, dog, and cat but also of the Rhesus monkey as well.[37] In an animal made completely diabetic by total removal of the pancreas, hypophysectomy alters markedly the classical features of the diabetes. The animal survives a much longer period; glycosuria may disappear completely and the blood sugar approaches normal. In the fasting animal hypoglycemia is frequently noted; there is a decrease in nitrogen

excretion; and ketonuria does not appear or is very much reduced. These changes are the result of removal of the anterior lobe of the hypophysis, as the retention of the posterior lobe apparently has no effect on the course of the diabetes. Such findings are in accord with the observations that a crude alkaline or acid extract of the anterior lobe of the hypophysis will produce hyperglycemia and glycosuria in normal dogs,[38-44] although no effects have been noted in rats when various types of commercial extracts have been used.[45] Considerable effort has been directed toward obtaining a relatively pure "diabetogenic" principle from anterior hypophyseal extracts with only a moderate amount of success. In his discussion of the nature of this substance,[46] Long is of the opinion that "one component of the 'diabetogenic' action of the anterior pituitary is prolactin or some substance that becomes closely associated with it in the methods at present used in its preparation."

The action of the cortex of the adrenal gland on carbohydrate metabolism resembles to a large extent that of the anterior lobe of the hypophysis. A review of the earlier experiments on this phase of metabolism has been recently published by Long and Lukens[47] and need not be repeated here. It is largely due to these two investigators and their colleagues that much light has been thrown on this problem. In his recent Harvey Lecture, Long[46] describes in detail this action. The effect of removal of the adrenal medulla apparently plays no important part in the amelioration of the symptoms of pancreatic diabetes. This function rests solely in the adrenal cortex. The effect on the depancreatized animal is so nearly identical with that of the anterior hypophysis that he raises the question as to a similar process being involved. In view of the fact that active extracts of the hypophysis of the "diabetogenic" type, capable of producing glycosuria in hypophysectomized-depancreatized cats, lose their action in the absence of the adrenal cortex, it is highly suggestive that this hypophyseal influence on carbohydrate metabolism takes place through intermediary action on the cortex of the adrenal gland.

There are other and divergent views as to the mode of action of both the hypophysis and the adrenal cortex. These need not be discussed at this time.

The action of the adrenal medulla in hypoglycemia is apparently a secondary one, having as its function the mobilization of sugar from the liver. Since Cannon developed this conception several years ago in relation to experimental hypoglycemia in dogs,[48] it has been elaborated upon, but has not been changed in its fundamental features. This increased output of adrenalin in hypoglycemia is not only associated with a rise in ventricular rate, but likewise in cardiac minute volume output. The hypoglycemia per se, however, apparently has a deleterious effect on the myocardium.[49] When hypoglycemia was induced in normal individuals with insulin given intravenously,[50] a rise in blood pressure was seen to

occur when the blood sugar level reached its lowest point and remained elevated until the normal blood sugar level was reached. The rise in the systolic pressure was approximately six times as great as the diastolic. It is interesting that this phenomenon was accentuated in patients with essential hypertension and absent in those with Addison's disease.

The action of the sympathetic nervous system as well as the thyroid secretion in the maintenance of the blood sugar level is apparently similar to that of the adrenal medulla. Further evidence that this is true will be considered later in this paper.

Macleod[51] has recently advanced the hypothesis of a center for the regulation of carbohydrate metabolism which he localizes in the pons. More recently, Ingram and Barris[52] have shown that in cats in which severe lesions were produced in the hypothalamus there was a definite tendency toward hypoglycemia with sensitivity to insulin.

It is quite obvious from the above discussion of the various factors at play in the maintenance of the normal blood sugar level that this is not a simple process but a complex one. That the islets of Langerhans play only one part in this mechanism is quite evident. The conception, therefore, of the hypoglycemic state as being the result of an excessive secretion of insulin is entirely too rigid an approach to the subject. There are many cases in which this is apparently true. Oftentimes some other explanation must be sought.[53]

SYMPTOMS

The earlier cases of hypoglycemia that were reported were quite clear-cut in their symptomatology. As other observations have been added, the symptomatology has become protean in its scope.[79] As a general rule—and there are many exceptions—symptoms are seen more frequently when the glycogen reserve in the liver is low, as is often the case in fasting, violent exercise, exposure to cold, and undue excitement.

An accurate classification of these symptoms is difficult. Many of them come about as a result of the effort on the part of the body to elevate the level of sugar in the blood. Others are the result of the hypoglycemia per se. Many articles have called attention to the marked similarity of the early findings to those of increased adrenalinemia, such as sweating, pallor, tremor, tachycardia, elevation of blood pressure, and fear. Recent contributions have offered further clinical substantiation of this. Wegierko[54] has recently observed three patients suffering from bronchial asthma, all of whom have been relieved for a considerable length of time following the production of hypoglycemic shock with insulin. Duncan[55] had under his care a patient who became angered because he was considered drunk during a hypoglycemic phase with immediate recovery from the hypoglycemia. While bradycardia has been observed,[56] this is not the general rule. Not only is tachycardia more common, but we have seen rather characteristic anginoid attacks

during the hypoglycemic phase similar to those seen in coronary insufficiency during emotional stress. This has been observed by others.[57] The gastrointestinal manifestations are not so easily explained. These vary from mild dyspepsia to intense abdominal pain, often resulting in needless abdominal operations. In view of the fact that increased intestinal motility has been observed in the hypoglycemic state, it is quite possible that the explanation may rest here. One of my earlier cases had had a previous cholecystectomy before he came to me and another an appendectomy. Bickel[58] observed two patients, one of whom presented the features characteristic of peptic ulcer and the other those of biliary colic. Both presented hypoglycemia and were relieved of their symptoms with adequate dietary measures for this condition. This aspect of the symptomatology has recently been reviewed quite adequately by Harris.[59]

The neuropsychiatric manifestations of this disease are most confusing. These may vary from diplopia and dizziness to personality changes, convulsions, and coma. Harris has recently reviewed these neurologic aspects[60, 61] and states that hyperinsulinism may simulate any of the neuroses or psychoses. At the same time it must constantly be borne in mind that many of these psychoses likewise show alterations in sugar tolerance. While emotional disturbances of a severe nature in those people free from mental disease is frequently accompanied by hyperglycemia, similar emotional disturbances in the mentally disordered usually do not show this change.[62] A variety of mental disorders have been studied during the past few years and the reports for the most part are contradictory.[63-72] While mental deterioration has been observed in patients with severe hypoglycemia,[165, 166] it does not follow that all patients with severe mental deterioration and hypoglycemia present a causal relationship. At the present time this offers one of the most difficult problems in differential diagnosis. If the mental disorder is secondary to the hypoglycemia, marked improvement often follows adequate medical or surgical treatment. If the hypoglycemia is an associated part of the psychosis, such treatment is generally of little permanent benefit.

Especially in the interpretation of epileptic convulsions have difficulties been encountered. Shortly after it became apparent that overdosage of insulin was associated with epileptiform seizures, patients with iodiopathic epilepsy began to be studied with an idea of derangement of carbohydrate metabolism. One of the earliest papers on the subject was that of Daley, Pryde, and Walker,[167] who found equivocal sugar values. Lennox, in his studies on blood sugar in this type of patient,[168,169] is of the opinion that the great majority of them show no fundamental disturbance and that changes when they do occur are for the most part the result of convulsive seizures rather than the cause. Nielsen,[170] however, found 90 per cent of his cases of iodopathic epilepsy

showing a tendency to hypoglycemia, although he does not consider that this alone is sufficient to produce an attack. He is of the opinion that the determination of the fasting sugar level, or even the sugar tolerance in such a patient, gives insufficient grounds for making a diagnosis of hyperinsulinism. My experience is in accord with this attitude. At the same time, it must not be forgotten that true hyperinsulinism mimics idiopathic epilepsy remarkably, and we have reported previously on cases so diagnosed. The experience of Whipple and his coworkers[5] along this line is dramatic.

The mechanism of the production of convulsive seizures in hypoglycemia is as yet not fully understood. Wohlwill[171] noticed changes in ganglion cells as well as ameboid changes in glial cells. Terplan[172] has verified these findings, noting especially changes in the occipital and frontal lobes and in the island of Reil and in the hippocampal gyrus. There was likewise considerable cerebral edema, a finding that might be used to explain occasional hypoglycemic headaches.[173] While postmortem change must always be taken into consideration in the explanation of such pathologic findings,[73] experimental results tend to corroborate them. Grayzel[74] found that in rabbits those animals with hypoglycemia without convulsions showed no lesions, while those with convulsions prevented hyperchromatic cells with corkscrew processes, and in those in which convulsions were most severe actual necrobiosis took place. The cells chiefly involved were particularly the pyramidal cells of the third and fifth cortical layers. He suggests that these changes may be the result of anoxemia and ischemia following circulatory changes produced by the convulsive seizures.

Olmsted and Logan demonstrated several years ago[75] that insulin convulsions probably had their origin in the respiratory center and were the result of anoxemia, while Holmes[76] showed that the consumption of oxygen in the gray matter was greater in the presence of glucose and was dependent upon the formation of lactic acid from glucose. These findings have been generally corroborated by Wortis.[77] The subject of the mechanism of the production of neurologic symptoms in hypoglycemia has been recently adequately discussed by Dameshek and Myerson.[78]

CLINICAL TYPES

A detailed discussion of the various clinical types that have been only recently described cannot be undertaken here. The reader is referred to numerous excellent reports[80-98] for a full description of various cases as well as interpretations of the hypoglycemic state.

Generally, hypoglycemia can be divided into two types, those cases associated with no demonstrable pancreatic lesion and those in which morphologic changes are demonstrable in the pancreas.

In the first group, juvenile hypoglycemia has received considerable attention during the past few years. Because of the frequency of convulsions in childhood, efforts were made relatively early to establish some relationship with altered carbohydrate metabolism. Often this could not be done. At the same time, autopsy reports of diffuse hyperplasia of the islet tissue began to appear in the literature just as did examples of congenital aplasia of the islets of Langerhans.[99] Others have appeared since those described in earlier reviews of the subject.[100, 101] Just as these cases began to be recognized earlier, so many of them have been treated successfully with adequate dietary measures. Especially has this been true of those infants born of diabetic mothers, a situation that is becoming more frequent since the advent of insulin. The effect of the ketogenic diet on the blood sugar of children has been recently studied by Talbot and Bates[104] and the entire subject of infantile hypoglycemia reviewed by others.[105-107] Darrow[108] has observed two children with convulsions associated with hypoglycemia and mental deficiency with x-ray evidence of anatomic lesions in the brain. It is suggested that the disturbance in the regulation of the blood sugar may have its origin in the cerebral lesions. This recalls the dramatic case reported by Graham and Hartmann[109] in which an infant with mental deterioration and a profound state of hypoglycemia that did not respond to dietary measures was greatly improved following subtotal resection of the pancreas. Congenital defects in the glycogen mechanism of the liver are likewise responsible for hypoglycemic states in infants. The first of these, described by von Gierke[110] as hepatonephromegalia glycogenica, is probably the result of the inability of the liver to discharge glycogen. An opposite condition, the failure of the liver to convert glucose to glycogen, with a resultant fatty infiltration of the liver has likewise been recently described.[111]

In the adult, hypoglycemia resulting from various hepatic disorders is well known. Primary carcinoma of the liver,[112-114] various types of atrophy of the liver,[115-117] fatty infiltration,[118] and toxic hepatitis following the administration of neoarsphenamine have been recently reported. Interestingly enough, however, thrombosis of the hepatic artery in a diabetic patient has been followed by a sudden marked resistance to insulin.[120] This could possibly be explained on the basis of the associated gangrene of the pylorus that was present and the associated toxemia. The presence of hypoglycemia in such hepatic disorders is generally a concomitant finding, found with other evidence of severe liver insufficiency, and, as a rule, causes no interpretative difficulties.

Thyroid, hypophyseal, and adrenal cortical insufficiencies are often associated either with hypoglycemic symptoms or hypoglycemic sugar tolerance curves.[117, 121-123] Generally, related clinical findings are present. Because of the interrelationships of these endocrine glands, pure types are often not seen. The action of the thyroid gland is at times

interesting. Ordinarily, it apparently aids in mobilizing sugar from the liver as do the adrenal medulla and the sympathetic nervous system. Because of this, when the thyroid is removed in a normal animal, there is generally an increase in sugar tolerance and a definite sensitivity toward the action of insulin. In hyperactive thyroid states, such as Graves' disease, the opposite is true. Occasionally in hypoglycemia, this glycogenolytic function of the thyroid may be necessary in the maintenance of normal blood sugar levels, and at such times the hypoglycemic patient may present an increased basal metabolism and other signs of thyroid hyperactivity. Recently with W. H. Cole I have reported on clinical observations of this type with a brief review of the action of the thyroid gland in this respect.[124] The case reported by Aitken[125] seems to fall in this group. The patient described by Gilmour and Walton[126] is interesting in this respect, in view of the fact that along with the nervous symptoms that were present the basal metabolism was increased 20 per cent. After removal of an adenoma of the islet cell type with relief of the hypoglycemia, the basal metabolism fell to minus 26 per cent, subsequently rising to minus 9 per cent.

Menstrual hypoglycemia and lowered blood sugar values associated with various types of vegetative imbalance have been recently described.[127, 128]

Besides these above hypoglycemic states obviously extrapancreatic in origin, there occurs a large group of patients presenting varying degrees of hypoglycemia in which no abnormality can be found either in the pancreas or in any of the other endocrine glands or the liver. The origin of this carbohydrate imbalance is difficult to explain at the present time, just as is the origin of a large group of cases of diabetes mellitus. Until more sensitive methods of differential study are developed, the interpretation of the origin of the lowered blood sugar will be difficult. This is of great clinical importance in view of the fact that often some of these patients resemble closely those with pancreatic islet hyperplasias.

Three types of anàtomic change have been described in the islets of Langerhans in patients with severe hypoglycemia. The first of these is one of generalized hypertrophy and hyperplasia of the islet tissue. In most of the patients so described, the lesion has been found shortly after birth or in infancy and has often been present in the offspring of diabetic mothers. This is interesting in consideration of the fact that Bensley demonstrated a number of years ago that in cases of dire necessity additional islet tissue could be formed from regenerating ducts. Further evidence that this hyperplasia is a compensatory phenomenon can be seen in the rapidity with which such hypoglycemic infants develop a stabilized carbohydrate metabolism following the institution of suitable dietary measures.

Another type of organic change seen in the pancreas in hypoglycemia is that of the so-called adenoma which is generally composed of beta

cells or of cells tending to resemble this type. Whipple and Frantz[4] were able to collect 21 cases in which this type of tumor was found at operation and 10 cases found at autopsy, all producing hypoglycemic symptoms. To this series I have been able to add 14 additional cases reported in the literature since then.[125, 126, 129-139] Obviously, this by no means represents all of the instances that have been observed. The lesion is being encountered often enough to prevent the reporting of numerous single cases that have been seen.

Cancer of the islet cell type presents the most profound states of hypoglycemia that are encountered clinically. Evangelisti,[140] in a fairly complete review of the literature, was able to collect only 8 cases to which he added a single case. To add to this series, I have been able to collect 4 additional cases.[141-144] This type of carcinoma is apparently extremely rare, and for this reason it is interesting to note its occurrence as well as that of the benign adenoma spontaneously in animals.[145-147]

PATHOLOGY

The proper study of the cellular changes in the islets of Langerhans as a rule requires more elaborate technical methods than are used in the ordinary study of pathologic tissue. Earlier studies on this aspect of the pancreas have been described by Bensley[148] and a later, more brief but adequate review may be found in Cowdry's recent *Textbook of Histology*,[149] and in the article by Bagley.[174] There is definite need at the present time for more data on the individual cell types in the islets, especially in those patients in whom there is clinical evidence of hypoglycemia, but in whom no tumors have been found. In one of my unpublished cases, there was an increase in the relative proportion of the alpha cells and in another there was a tendency to vacuolization of the beta cells, suggesting overwork.

The cytologic picture in adenomas of the islets has been described in detail by O'Leary and myself[150] and by Whipple and Frantz.[5] The tumors may be single or multiple. They vary in size from a few millimeters to many centimeters, but as a rule they tend to be unusually small. While generally encapsulated, this is not always true. When seen grossly in the pancreas, the appearance is that of a localized, elevated, cyanotic area, at times resembling a hematoma. Microscopically, in our experience, the majority cell type, if not identical, was closely related to the beta cell in staining characteristics. Generally speaking, the toxicity of the tumor depends more upon the maturity of this differentiation toward the beta cell than it does upon the size of the tumor. Degenerative and hemorrhagic areas are frequently encountered, as is hyalinization. We have seen this latter phenomenon apparently completely replace such an adenoma. Interesting enough, the islet tissue removed from the normal pancreas, away from a functioning adenoma, is apparently normal in every respect. Tissue from two islet cell

adenomas has been cultured in vitro successfully. Subsequent transplants of this cultured tissue into diabetic patients failed to produce clinical improvement in the diabetes.[151]

Because of the cytologic similarity of many of the benign growths to carcinoma, the diagnosis of malignant disease must be made with care. Before making such a diagnosis, we prefer to have present (1) invasion of the capsule associated with (2) invasion of blood vessels or with (3) metastases.

DIAGNOSIS

Since the symptoms produced by hypoglycemia are caused by a lowered level of sugar in the blood, it is of the utmost importance that the presence of such symptoms be related directly to the hypoglycemia. The production of hypoglycemia, either with insulin or by fasting, offers an excellent opportunity to reproduce the symptom-complex.

Single fasting sugar determinations are of little value. Even glucose tolerance curves are often confusing in their interpretation. In a recent study of the respiratory metabolism in hyperinsulinism following the ingestion of glucose, Rabinowitch and Fowler[152] concluded that flat sugar curves were evidence of hyperinsulinism. They draw attention to the fact that the type of curve obtained depends upon whether the converted glycogen is to be used for storage or oxidation, and this in turn is determined by the amount of glycogen present in the liver before the glucose is ingested.

Insulin tolerance tests have generally been within normal limits in those patients in whom tumors have been subsequently found. Abnormal sensitivity or resistance to insulin is highly suggestive of extrapancreatic origin of the hypoglycemia. This is likewise true of the action of adrenalin. Failure of adrenalin to elevate the level of sugar in the blood has generally been ascribed to lowered glycogen reserve in the liver. That this may not always be the case is suggested by the work of Cope and Marks,[153] who found that in the absence of the anterior lobe of the hypophysis the liver glycogen is not discharged in the usual manner. In an unpublished observation in a patient with hypoglycemia showing clinical evidence of anterior hypophyseal insufficiency, however, I found no difference in the amount and rate in the glycogen discharge after the injection of adrenalin. It is highly probable that, although there was hypophyseal insufficiency present, this was not of a degree severe enough to produce the abnormality as described above. A better explanation, however, is offered in the recent results of Russell and Cori,[175] who have demonstrated that the difference in the glycogenolytic effect of adrenalin in the normal and hypophysectomized animals is due to a diminished rate of absorption of the adrenalin from the subcutaneous tissue in the hypophysectomized animal. In several instances I have observed a split action on the part of the adrenalin in the sense that the pressor effect,

as evidenced by blood pressure readings and the pulse rate, did not necessarily parallel the glycogenolytic effect of the adrenalin. In none of these cases was there sufficient evidence of tumor to warrant exploration.

The differentiation between the presence or absence of tumor cannot be made with any degree of certainty, at the present time, before operation. In no case in which there was considerable doubt as to the presence of tumor before operation have I encountered one at exploration.

TREATMENT

In consideration of the treatment of hypoglycemia, the conception of this condition as the antithesis of diabetes mellitus can again be used. Originally, medical therapy was directed at a high carbohydrate diet. It was soon found, however, that while this was excellent therapy for the acute shock, it eventually led to an increase in the carbohydrate tolerance with resulting increase in the frequency and severity of the attacks. A diet relatively low in carbohydrates and high in fats was substituted with much better effect. The action of such a diet on glucose tolerance has been described by Clark and Greene.[154] John[155] added to such a regimen twenty units of insulin one-half hour after each meal with excellent results. It is his opinion that such treatment has but little effect on the anatomic type of hypoglycemia and thus can be used as a means of differentiation from the functional type. Conn[156] has recently suggested the use of a high protein diet in the treatment of spontaneous hypoglycemia, based on the facts that it causes no hyperglycemia and thus avoids excessive production of insulin and secondary hypoglycemia; it provides a source of glucose over a long period of time and thus allows severe cases further restriction of carbohydrates than could otherwise be effected.

With the rationalization of dietary treatment of the condition, the necessity of surgical intervention has become much less, just as has the use of similar dietary methods in the treatment of diabetes mellitus reduced the number of patients in which the use of insulin is an absolute necessity. There are times, however, when the use of large amounts of insulin is necessary in diabetes, and likewise in hypoglycemia there are times when the most carefully carried out dietary regimen is not sufficient. While x-ray therapy has been suggested,[157] most opinions favor surgical exploration in such cases.

The surgical technique employed in such explorations is not extraordinary and has been sufficiently described in many of the above references. If a localized tumor is found, it is generally located either in the tail or the body, though not necessarily so. The head of the pancreas should always be explored, regardless of whether a lesion is encountered elsewhere or not. There are several reports on record of multiple tumors.

If no apparent tumor is present, the question of partial resection of the pancreas must be considered. The reports of the efficacy of such a procedure are equivocal.[158-162] As Roscoe Graham has pointed out,[158] it is quite possible for a pancreas with normal appearing islets anatomically to show on assay an insulin content that is much greater than normal. As a general rule, those instances in which less than one-half of the pancreas has been removed have been associated with unsatisfactory results. There are many reports, however, in which a satisfactory result has followed the extirpation of a larger amount of the pancreas. Whether the results here can be considered in terms of proportion of the pancreas removed cannot be definitely determined until the accumulation of more complete data. The attitude at present cannot be dogmatic; however, the analogy of removal of pancreatic tissue in hypoglycemia to the giving of insulin in diabetes mellitus suggests that it is a question of dosage. Just as an insufficient amount of insulin in the treatment of diabetes mellitus is of little value, so removal of an insufficient amount of pancreatic tissue in hypoglycemia would be of little value. Comparison has been made in times past with the thyroid gland in Graves' disease. The accomplishment of adequate therapeutic results in the surgical treatment of hyperfunctioning of the thyroid gland is most often associated with subtotal thyroidectomy. It was this conception that led Graham and Hartman[109] to deliberately operate upon an infant in order to remove an enormous amount of pancreas tissue.

The operation of partial pancreatectomy is often quite difficult technically, especially in adipose, hypersthenic types. The danger of injury to the splenic vein is a definite one. Where this has been done and ligation is necessary, if the spleen cannot be easily removed as has been suggested by Holman, collateral circulation may be established by scarifying the spleen and covering it with omentum.

The presence of pancreatic cysts and fistulas does not, as a rule, present a serious problem.[163]

Any surgical procedure in which the liver is deficient in glycogen may be dangerous. Because of the frequency with which the glycogen reserve may be used up in the hypoglycemic patient, much care must be used in this regard. While this has been a clinical observation for some time, the experimental work of Kosterlitz[164] is especially interesting. He noted that in the fed rat, where there is ample liver glycogen, a fall in blood pressure below a critical point is accompanied by hyperglycemia. In the fasted rat, however, with the liver glycogen reduced to a minimum, a fall in blood pressure below such a critical value is associated with a rapid decrease in the blood sugar level, probably due to the suppression of gluconeogenesis consequent to the fall in blood pressure. Upon restoring the blood pressure to its normal level with acacia or blood transfusion, the normal sugar level is established.

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Review of Recent Meetings

SIXTY-SECOND ANNUAL MEETING OF THE AMERICAN GYNECOLOGICAL SOCIETY SWAMPSCOTT, MASS., MAY 31, JUNE 1 AND 2, 1937

WILLIAM J. DIECKMANN, M.D., CHICAGO, ILL.

(From the Department of Obstetrics and Gynecology, the University of Chicago)

The Upper Pelvic Floor, and Its Importance in Total Abdominal Hysterectomy. By Dr. Lillian K. P. Farrar, New York, N. Y.: The term upper pelvic floor is intended to include all the tissues attached to the cervical portion of the uterus including the nerves, lymphatics, blood vessels, and ureters lying in the broad ligaments, the adjacent muscles which are adherent to the broad ligaments by their fascial coverings and the muscles which are attached to the vagina and thereby contribute to the support of the uterus. If a technique is followed in total abdominal hysterectomy that is very similar to that commonly employed in vaginal hysterectomy, the uterus may be removed with little injury to the upper pelvic floor and with good conservation of the supporting structures which remain.

A Modification of the Le Fort Operation Which Greatly Increases Its Scope. By Dr. J. R. Goodall, Montreal, Quebec: The Le Fort operation consists of a marsupialization of the vagina to correct procidentia. It has its well-defined limitations. It is restricted more or less to women past the menopause, and preferably to elderly widows. In the present modification, it is imperative only that the patient be sterile. The marsupialization is restricted to the vault of the vagina, descending a distance that will vary with the vaginal capacity. The further narrowing of the vagina below this is continued by an anterior colporrhaphy and perineorrhaphy. The upper marsupialization forms an excellent point d'appui and does not interfere with marital relations. The modification finds its best application following vaginal hysterectomy in complete procidentia.

An Efficient Composite Operation for Uterine Prolapse. By Dr. Edward H. Richardson, Baltimore, Md.: Complexity of the surgical problem presented by advanced grade vaginal hernias was stressed. No single plan of reconstruction surgery has been devised yet that is applicable to all types. Indications vary in the two age groups. There was discussion of several factors involved and enumeration of the various operations commonly employed today with a brief discussion of the rational use and limitations of each. The need for a composite operation, its scope and aim were considered and the technique described.

Prolapse of the Uterus—Shifting Trends in Treatment. By Dr. Joseph L. Baer, Chicago, Ill.: During the years 1929 to 1935, inclusive, 221 operations for the cure of prolapse were performed by the gynecologic staff of Michael Reese Hospital. A comparable series of 220 operations was reported before this Society in 1928. In the original series interposition was the operation of choice; whereas, vaginal hysterectomy exhibited in the literature current ten years ago led to the spontaneous introduction of vaginal hysterectomy as the method of choice at Michael Reese Hospital for the

Received for publication, September 17, 1937.

cure of prolapse. Many other operations were utilized as in the previous series. A comparison of the results obtained is presented.

The Continuous Auscultation of the Fetal Heart by Means of an Amplifying Stethoscope (Preliminary Report). By Dr. Harvey B. Matthews, Brooklyn, N. Y.: The importance of the continuous auscultation of the fetal heart is unquestionable. Early manifestations of fetal distress could be more often recognized if it were possible to continuously auscultate the fetal heart. An amplifying stethoscope conducting the output through a loud speaker has been devised by means of which this can be accomplished. After placing the receiving diaphragm over the fetal heart i.e., the area of the mother's abdomen where the fetal heart is loudest, the operation is simple: plug in, tune in, and listen.

Symposium on Eclampsia: The Prevention of Eclampsia. By Prof. K. de Snoo, Utrecht, Holland: The author presents his experience in over twenty-five years in 2,000 women with toxemia. His theories concerning eclampsia are discussed and his routine treatment presented. Prenatal care inside and outside the clinics is pictured. In Holland the prenatal care outside the clinics is chiefly in the hands of midwives who have learned to measure blood pressure and to examine urine. There is a league for prenatal care which organizes and supervises the regular examinations. The public in Holland has gradually been educated to expect prenatal care. In 175,000 births, the mortality from eclampsia is approximately 1 in 3,000.

Analgesia and Anesthesia and Their Bearing Upon the Problem of Shortened Labor. By Dr. Arthur H. Bill, Cleveland, Ohio: The conduct of painless labor is not an experiment and has not been such for the last twenty or twenty-five years. Labor may be made practically painless and delivery performed under anesthesia safely for mother and child. Some unfavorable results of childbirth have been unjustly attributed to analgesia and anesthesia. The question today is not whether we can make labor painless, but what the proper choice of methods for accomplishing this should be. No single method will serve every case well and no single method is suitable for the conduct of the entire labor. A proper combination of methods is to be preferred. The combination depends upon the character of the labor, whether first stage or second stage, and whether the patient is a primipara or a multipara. Drugs promoting analgesia or amnesia are essentially suitable only for the first stage. The general anesthetics are to be preferred for the second stage and delivery; however, the latter may be used during a varying part of the first stage. From a strictly obstetric point of view, the general anesthetics are of two types, depending upon whether they do or do not cause complete relaxation of the uterus. The advantages of each are illustrated. A proper choice in the individual case is important. Painless labor does not lead to meddlesome interference. Often quite the opposite is true. The best way to insure a spontaneous course of the first stage is to make it painless. Interference is usually promoted by a desire to relieve suffering. The birth may be spontaneous or not, depending upon the judgment of the obstetrician more than upon the anesthesia.

A Study of the Hormonal Content of Ovarian Cysts. By Dr. Fred L. Adair, Chicago, Ill.: About 200 specimens of fluid obtained from cystic genital tumors have been studied chiefly for the presence of estrogenic substance. Most of these tumors are usually classed as of ovarian origin. These findings have been compared with the gross and microscopic appearance of the fluids and tissues obtained at operation. Some fluids show it in high degrees of concentration and others show this substance in very low concentration or not at all. This suggests that certain fluids contain an amount of this substance comparable to that present in other

tissues and that it is probably extrinsic in origin. Other cysts appear to secrete this estrogenic substance and it is therefore intrinsic in origin.

Observations Pertinent to Gonadotropic Therapy in Gynecology. By Dr. Robert A. Ross, Durham, N. C.: For the past six years Dr. Ross and his coworkers have studied ovaries and endometria of patients who had received injections of gonadotropic principles. They were concerned originally with the possibility that some of the effects observed in animals might occur in the human. Later they have tried to explain such paradoxes as instances of clinical improvement without significant histologic changes. Recent studies have concerned primarily responses in anovulatory states. An attempt to employ the endometrium as an indicator of the levels of ovarian function has resulted in an alteration of their classification of endometrial patterns. These studies have suggested, in addition, an avenue which may help ascertain the required clinical dose of these preparations. Such a dose is influenced by various factors which include the age of the patient, associated pelvic conditions, as well as individual tissue receptivity.

The Clinical Significance of Endometrial Hyperplasia. By Dr. Franklin L. Payne, Philadelphia, Pa.: The statement that endometrial hyperplasia does not necessitate abnormal uterine bleeding is proved in this study. The material consists of 496 premenopausal and 38 postmenopausal specimens of endometrial hyperplasia. Analysis of the premenopausal hyperplasia group shows that abnormal uterine bleeding occurred in 85.2 per cent of the patients, the remainder having normal, scanty, or absent periods. The incidence of hyperplasia in the clinical conditions which are commonly associated with it and the incidence of abnormal bleeding in these conditions are shown. The association of fundal malignancy with both pre- and postmenopausal hyperplasia is discussed. Analysis of the postmenopausal group shows hyperplasia to occur either with or without demonstrable pelvic pathology and often in the absence of uterine bleeding.

An Unusual Obstetrical Injury, Detaching Bladder and Urethra From the Symphysis Pubis and Causing Complete Epispadias. By Dr. Guy L. Hunner, Baltimore, Md.: A primipara, aged thirty-eight years, with adequate pelvic measurements, in a spontaneous delivery of an 8.5 pound boy, with R. O. A. position, remained in the second stage of labor sixty-six hours. After complete dilatation of the cervix and spontaneous rupture of the membranes, there was precipitate birth. Dr. Hunner described the injury, particularly to the urethra, as well as the subsequent treatment and results.

Presidential Address. By Dr. Fred J. Taussig, St. Louis, Mo.: An excellent résumé of the history of eclampsia, toxemia of pregnancy, and prenatal care.

Pregnancy Complicated by Ovarian Tumors. By Dr. Karl M. Wilson, Rochester, N. Y.: Such tumors complicating pregnancy may at times cause no trouble, but more often they are to be regarded as a serious menace. Formerly, the mortality associated with this complication was high, but modern surgical methods have reduced this considerably. The principal dangers lie in abortion, torsion of the pedicle of the tumor, or the production of a mechanical obstacle to labor. A series of twenty-eight cases from the author's service is presented. In this small series all the above complications were noted. The most interesting group in the series is found in those patients where removal of the tumor necessitated removal of the corpus luteum. There is a discussion of the indications and time for operation. There were no deaths in the series.

Biologic and Clinical Import of Vulvovaginal Mycosis. By Dr. H. Close Hesseltine, Chicago, Ill.: A brief review was given. The variable incidences, methods of spread, and influence of physiologic states of the vulva and vagina were explained. Methods for identification of the medical monilia and cryptococci were discussed. The significance of the disease and a similarity of certain vulva mycoses to early stages of kraurosis were emphasized. Tables illustrated the fungicidal potency of element iodine and data showed the therapeutic value of potassium iodide-potassium iodate mixture in a neutral inert diluent. Some metabolic products from glucose by these fungi were suggested and an explanation was offered for a type of tissue reaction.

The Etiology of Congenital Malformations in the Light of Biological Statistics. By Dr. Douglas P. Murphy, Philadelphia, Pa.: Dr. Murphy presented observations on biological and other characteristics of a series of families possessing congenitally malformed children. He gave an evaluation of this material as it helps to explain the cause of congenital defects.

Sarcoma of Uterus—Clinical and Pathologic Study of Fifty-Nine Cases. By Dr. Emil Novak, Baltimore, Md.: This paper was based on clinical and pathologic study of 59 cases of uterine sarcoma in a total of 26,973 case specimens in a twenty-five-year period. The series included 2 cases of sarcoma botryoides. Incidence, symptomatology, diagnosis, and end-results were discussed. Of 50 cases traced, 12 were alive and well five or more years; 17 dead within one year after operation; the total five-year salvage was 30 per cent (15 cases). The paper was devoted chiefly to pathologic aspects, with discussion of histogenesis, types, microscopic diagnosis, degrees of malignancy on basis of cell type and mitotic activity, etc. Application of these facts to general principles of treatment was presented.

The Results of Conservatism in the Treatment of Premature Separation of the Normally Implanted Placenta. By Dr. Frederick C. Irving, Boston, Mass.: Material: 359 cases from the Boston Lying-In Hospital.

1. External hemorrhage, 240
   - A. Expectancy, rupture of the membranes, small doses of pituitary extract or dilating bag, 211; 3 deaths, 1.4 per cent
   - B. Cesarean section, 29 cases; 1 death, 3.4 per cent

   Conservative measures give better results for the mother.
2. Internal hemorrhage, 119
   - A. Pelvic operative delivery, 16 cases; 3 deaths, 18.7 per cent
   - B. Cesarean section, 69 cases; 10 deaths, 14.5 per cent
   - C. Conservative measures, 34 cases

     Expectancy, 8; rupture of membranes, pack and Spanish windlass, 26 cases, 1 death; rate for conservative treatment, 2.9 per cent

     Conservative measures have given ⅙ of the mortality of pelvic operative delivery and ⅕ of that of cesarean section.

Erratum

On pages 570 and 571 of the October issue, in the article by Best and Hicken entitled "A Probable Cause for the High Mortality Following Cholecystostomy Cholecystogastrostomy, and Cholecystoduodenostomy in Jaundiced Patients," Figs. 2 *A* and 2 *B* were printed upside down.

Book Reviews

A Manual of Operating Room Procedures. By Almira W. Hoppe and Lucile M. Halverson. Pp. 239. Minneapolis, 1937, The University of Minnesota Press. $2.

This book is a comprehensive, detailed guide with considerable merit for nurses, internes, and surgeons. There is unquestionably a universal need for such a book and it should serve the purpose of reducing the confusion often present in operating rooms in general because of the absence of information arranged in a systematic way. The most commendable part of the book is a brief description of what is to be accomplished, as well as the steps of different operations. This information should be of great value to the nurse, leading to proficiency of a higher degree in the operating room. This particular knowledge should be of great value and applicable to any operating room.

The immense amount of detail as to instruments, sutures, etc., is of value to one particular group of surgeons, but since each surgeon has his own ideas and peculiarities, a more general outline of instruments, equipment, etc., would be of more use to operating rooms in general. An outline indicating the type of instruments, rather than instruments named for some doctor, when possible, would be less confusing.

This is a very creditable book and a very reasonable one. Any operating room would profit by the possession of this guide, which may be and should necessarily have to be modified to conform to local conditions and ideas. It is printed on only one side of the page so that supplementary notes and changes may be conveniently made.

Wundheilung. By Wilhelm Löhr. Pp. 234, with 141 illustrations. Leipzig, 1937. Johann Ambrosius Barth. 21 marks.

Texts on the treatment of wounds, it might appear, would be quite unnecessary inasmuch as many of the general surgical texts are written about this central tenet. On the contrary, this fundamental concern of all surgeons is particularly deserving of monographic consideration. When a surgeon analyzes critically his success and failures in the management of acute pyogenic surgical infections, he cannot feel very arrogant over his accomplishments; if he is alive to what his rôle has been, it must occasion in him a sense of true humility.

The author of this text has long had a keen interest in surgical infections and is the author of another text on anaerobic infections. In this monograph, Löhr discusses the various adaptations of the cod liver oil ointment dressings in the treatment of wounds, of which he is the author. All who have tried the method undoubtedly have found some virtue in it. It is difficult to escape the impression, however, that the author credits it more than the method deserves.

The author rightfully stresses the great importance of conservation in the treatment of infections of the extremities. He indorses the Orr treatment of acute and chronic osteomyelitis and discusses in a conservative and orthodox manner the matters of mechanical and chemical cleansing of wounds as well as the place of drainage in the treatment of surgical infections.

This thoughtful consideration of wound management and surgical infections can be enthusiastically recommended to every surgeon for study. Wound treatment, once the chief occupation of the surgeon, merits his continued interest and concern.